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NASA/AMERICAN SOCIETY FOR ENGINEERING
EDUCATION (ASEE) SUMMER FACULTY
FELLOWSHIP PROGRAM 1987

Surendra N. Tiwari (Compiler)

OLD DOMINION UNIVERSITY
NORFOLK, VIRGINIA

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National Aeronautics and
Space Administration

Langley Research Center
Hampton, Virginia 23665

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Section I

ORGANIZATION AND MANAGEMENT

The 1987 Old Dominion University-NASA-Langley Research Center Summer Faculty Research Program, the twenty-fourth such institute to be held at the Langley Research Center, was planned by a committee consisting of the Co-Director, Langley staff members from the Research Divisions and the Office of University Affairs. It was initiated under the auspices of the Langley Research Center Chief Scientist Mr. Jerry C. South, Jr. and was completed under the auspices of Dr. Richard W. Barnwell.

Each individual applying for the program was provided a listing of research problems available to the Langley Fellows. Each individual was requested to indicate his or her problem preference by letter to the University Co-Director. The desire to provide each Fellow with a research project to his/her liking was given serious consideration.

An initial assessment of the applicant's credentials was made by the NASA-Langley University Affairs Officer. The purpose of this assessment was to ascertain to which divisions the applicant's credentials should be circulated for review. Each application was then annotated reflecting the division to which the applications should be circulated. After the applications had been reviewed by the various divisions, a committee consisting of staff members from the various divisions, the University Affairs Officer and the University Co-Director met. At this meeting the representatives from the various divisions indicated those individuals selected by the divisions.

The University Co-Director then contacted each selected Fellow by phone extending the individual the appointment. The University Co-Director also forwarded each selected Fellow a formal letter of appointment confirming the phone call. Individuals were given ten days to respond in writing to the appointment. As letters of acceptance were received, the University Affairs Officer contacted the various Directorate Technical Assistants advising them of their Fellows for the summer program.

Each Fellow accepting the appointment was provided material relevant to housing, travel, payroll distribution and a listing of all NASA-Langley Research Fellows. Each Fellow, in advance of commencing the program, was contacted by his or her Research Associate or a representative of the branch.

At the assembly meeting, Dr. Samuel Massenberg, the NASA-Langley University Affairs Officer, introduced the Langley Research Center Associate Director, Mr. Sidney F. Pauls, who formally welcomed the Summer Fellows. Mr. Richard Meeks, Manager, Langley Research Cafeteria, briefed the Fellows relevant to the cafeteria policies, hours, etc. Mr. Samuel McPherson, III of the Computer Management Branch briefed the Fellows on the Computational Facilities. The subject of security at the Langley Research Center was discussed by O. J. Cole, Chief, Security Branch. Further instructions were given and information disseminated by Dr. Samuel E. Massenberg and Dr. Surendra N. Tiwari, Co-Director, ASEE program.

Throughout the program the University Co-Director served as the principal liaison person and had frequent contacts with the Fellows. The University

Co-Director also served as the principal administrative officer. At the conclusion of the program, each Fellow submitted an abstract describing his/her accomplishments. For presentation of research activities by the Fellows, the practive adopted during the past year was followed. Each Fellow gave a talk on his/her research within the division. The Research Associate then forwarded to the Co-Director the name of the person recommended by the division for the final presentation. Twelve excellent papers were presented to the Research Fellows, Research Associates and invited guests. The presentations were all given in one day.

Each Fellow and Research Associate was asked to complete a questionnaire provided for the purpose of evaluation of the summer program.

Section II

RECRUITMENT AND SELECTION OF FELLOWS

RETURNING FELLOWS

An invitation to apply and participate in the Old Dominion University-Langley Research Center Program was extended to those individuals who held previous Langley Fellow appointments. Sixteen individuals responded to the invitation, however, only six were selected. Forty-two applications were received from Fellows from previous years or from other programs.

NEW FELLOWS

Although ASEE distributed a combined brochure of the Summer Programs, many personal letters were mailed to Deans and Department Heads of various engineering schools in the East, South and Midwest, by Dr. Surendra Tiwari and Mr. John Spencer of Hampton University, requesting their assistance in bringing to the attention of their faculties the Old Dominion University/Hampton University-Langley Research Center Program. In addition to the above, a number of departments of chemistry, physics, computer science and mathematics at colleges (including community colleges) and universities in the State of Virginia as well as neighboring states were contacted regarding this program. Although minority schools in Virginia and neighboring states were included in the mailing, the Co-Director from Hampton University made site visits to minority schools soliciting applicants, and sent over three hundred letters to Deans and Department Heads. These efforts resulted in a total of one hundred seventeen formal applications, all indicating the Old Dominion University-Langley Research Center Program was their first choice and a total of forty-two indicating ODU-LaRC Program was their second choice. The total number of applications received came to one hundred fifty-nine (Table 1).

Forty-two applicants formally accepted the invitation to participate in the program. Nine applicants declined the invitation. Several Fellows delayed their decision while waiting for acceptance from other programs. The top researchers seem to apply to more than one program and will make their selection based on research interest and stipend.

The average age of the participants was 41.3.

TABLE 1

First Choice Applications

Total	Females		Males		Minority Schools Represented
	Black	NonBlack	Black	NonBlack	
117	1	4	6	64	8

Second Choice Applications

Total	Females		Males		Minority Schools Represented
	Black	NonBlack	Black	NonBlack	
42	1	1	7	33	10

NASA-LaRC FELLOWS

Total	Females		Males		Minority Schools Represented
	Black	NonBlack	Black	NonBlack	
42	0	3	9	30	8
	First Year Fellows		Returnees		Number Declined
	33		9		9
	Positions Funded NASA/ASEE				Local Purchases
	36				6

Section III

STIPEND AND TRAVEL

A ten-week stipend of $8,000 was awarded to each Fellow. Although this stipend has improved over previous years, it still falls short (for the majority of Fellows) of matching what they could have earned based on their university academic salaries. This decision on their part does, however, clearly reflect the willingness of the Fellow to make some financial sacrifice in order to participate in the summer program.

Travel expenses incurred by the Fellows from their homes to Hampton, Virginia, and return were reimbursed in accordance with current state regulations.

Section IV

LECTURE SERIES, TOUR, AND PICNIC

LECTURE SERIES

In response to statements made by the Research Fellows the Lecture Series was again arranged around research being done at LaRC and the speakers were Langley research scientists.

Appendix III contains the agenda for the special ASEE Summer Lecture Series for 1987.

TOUR AND PICNIC

A briefing and tour of the Technical Library facilities was arranged for the first year Fellows on June 5, 1987.

A picnic for the Fellows, their families, and guests was held on June 19, 1987.

Section V

RESEARCH PARTICIPATION

The 1987 Old Dominion University-Langley Research Program, as in the past years, placed greatest emphasis on the research aspects of the program. Included in this report are abstracts from the Fellows showing their accomplishments during the summer. These abstracts, together with the comments of the Langley Research Associates with whom the Fellows worked, provide convincing evidence of the continued success of this part of the program. The Fellows' comments during the evaluation of the program indicated their satisfaction with their research projects as well as with the facilities available to them.

The research projects undertaken by the Fellows were greatly diversified as is reflected in their summer research assignments. Their assignments were as follows:

Number of Fellows Assigned	Division
3	Analysis and Computation Division
2	Instrument Research Division
6	Flight Electronics Division
3	Structures and Dynamics Division
2	Materials Division
2	Transonic Aerodynamics Division
1	Low-Speed Aerodynamics Division
1	High-Speed Aerodynamics Division
2	Atmospheric Sciences Division
4	Space Systems Division
5	Information Systems Division
2	Guidance and Control Division
3	Flight Management Division
1	Personnel Division
1	Business Data Systems Division
1	Interdisciplinary Research Office
1	Office of Public Services
1	Systems Engineering Division
1	Loads and Aeroelasticity Division

Thirty-seven of the participants were holders of the doctorate degree. Five held the masters degree. The group was a highly diversified one with respect to background. Areas in which the last degree was earned:

Number	Last Degree
1	Applied Science
2	Aerospace Engineering
1	Solid State Physics
1	Theoretical Physics
2	Chemistry
3	Physical Chemistry
1	Analytical Chemistry

1	Nuclear Chemistry
4	Engineering Mechanics
4	Mechanical Engineering
1	Education
1	Meteorology
2	Electrical Engineering
1	Engineering Science
3	Physics
3	Industrial Engineering
1	Aerospace
1	Mathematics
1	Applied Mathematics
1	Materials Engineering Science
3	Computer Science
1	Dynamics and Control
1	Statistics
1	Journalism/Mass Communication
1	Management Information System and Operations Research

EXTENSIONS

A portion of the funds remaining in the travel budget was used to grant extensions to six Fellows in the program. To be considered for the extension the Research Fellow submitted a statement of justification which was supported by the Research Associate. The requests were reviewed by the University Director and the Director for University Affairs. The following individuals were granted extensions:

Clarence de Silva	1 Week
Devendra Garg	1 Week
Calvin Lowe	2 Weeks
Ezzatollah Salari	1 Week
Charles Spellman	3 Weeks
Joan Sprigle-Adair	2 Weeks

ATTENDANCE AT SHORT COURSES, SEMINARS AND CONFERENCES

During the course of the summer there were a number of short courses, seminars and conferences, the subject matter of which had relevance to Fellows' research projects. A number of Fellows requested approval to attend one or more of these conferences as it was their considered opinion that the knowledge gained by their attendance would be of value to their research projects. Those Fellows who did attend had the approval of both the Research Associate and the University Co-Director. The following is a listing of those Fellows attending either a short course, seminar or conference:

Carl Andersen attended the Second International Conference on Artificial Intelligence in Engineering.

Jeffrey Bennighof attended the ICASE Workshop on Identification and Control, June 6-10, where he gave a presentation. He also attended the 6th

VPI&SU/AIAA Symposium on Dynamics and Control of Large Structures, June 29-July 1, in Blacksburg, Virginia.

Devendra Garg attended the ICASE Workshop on Control and Identification, June 8-12. He also attended the following seminars: Feedback Linearization and Robust Controller Synthesis by Dr. R. Su, University of Colorado, Boulder, Co; Robust Stability: Efficient Finite Test by Dr. N. K. Bose, Penn State University, Univ. Park, PA; Airforce Forecast Technology and Systems Program: Forecast II Study by Lt. Col. Mushala, US Air Force.

Joseph Hafele attended a private conference (meeting) at US Naval Observatory in Washington, DC.

Alton Highsmith attended a seminar by Dr. X. R. Wn, entitled "Weight Function Analyses in Fracture Mechanics."

Kakkattuzhy Isaac attended a seminar by R. W. MacCormack, entitled "Chemically Reacting Flowfield Computation."

Eric Klang attended a seminar on Experimental Stress Analysis Techniques for the Teaching Laboratory by the measurements group.

J. Patrick Lang attended the HARP progress report and the Boeing IAPSA semi-annual progress report. He also attended a lecture by Rick Butler on the Formal Verification of Software.

Mark Norris attended the following: Society for Experimental Mechanics Conference, Houston, Texas; AIAA/VPI&SU Symposium on Dynamics and Control of Large Structures; ICASE Workshop: Identification and Control of Flexible Structures, and various ICASE colloquiums.

Kenneth Sobel presented a paper at the 1987 American Control Conference on June 10-12, in Minneapolis, MN.

John Van Norman attended the Gordon Research Conference on "Catalysis", Colby-Sawyer College, New London, NH, June 22-26.

Reginald Walker was a participant in the National Technical Association's 1987 Conference.

In addition to the above there was attendance and participation in conferences, seminars and short courses held at the Langley Research Center.

<u>ANTICIPATED PAPERS RESULTING FROM FELLOWS RESEARCH EFFORTS</u>

Image Enhancement of Solid-Melt Interfaces in Lead Tin Telluride - to be submitted to Journal of Crystal Growth - Patrick Barber.

Dynamic Evaluation of a Traction Drive Joint for Space Telerobots - to be submitted to Measurements and Control Journal - Clarence de Silva.

A Simulation Model of Shuttle 2 Operations. A 0-1 Program for Selecting

Advanced Space Missions - to be submitted to IEEE Transactions on Engineering Management - Gerald Evans.

Simulation Studies of the Size Distribution of Atmospheric Aerosols - to be submitted to Journal of Chemical Physics - Winston Farrar.

Benchmark Solutions for the Galactic Ion Transport Equation Radiation Research - Barry Ganapol.

Effect of Atomic Oxygen on Various Polymeric Materials - Richard Kiefer.

Analysis of Bonded Structural Components Using a Higher Order Plate Theory- Eric Klang.

Two-Component Injection/Turbulent Mixing Analysis - N. Kondic.

A Decision Support System for On-Orbit Operations - to be submitted to Journal of Operations Management. Also, Dynamic Sequencing and Scheduling of Mission Support Tasks - to be submitted to IEEE Transactions on Engineering Management - James Luxhoj.

Operation of $Ti:Al_xO_x$ in a MOPA Configuration - George Miller.

Vortex Detection in an Image Sequence - Ezzatollah Salari.

Eigenstructure Assignment for Control of Highly Augmented Aircraft - to be submitted to the 1988 American Control Conference, June 15-17, 1988, Atlanta, Georgia.

The Aerospace Technician: Learners Today, Leaders Tomorrow - Charles Spellman.

Impact of Wind Shear on Airplane Performance - to be submitted to AIAA Journal of Aircraft - Robert Wattson.

Verification and Validation: Foundations of Applying Traditional Testing Techniques to Artificial Intelligence Type Programs - Robert Willis.

Structural Dynamics and Vibrations of Lightly Damped Systems - to be submitted to Journal of Sound and Vibration - Maurice Young.

Other Fellows are planning papers based on their research but have not solidified their plans at this time.

ANTICIPATED RESEARCH PROPOSALS

Image Enhancement Applied to Crystal Growth - Patrick Barber.

Parallel Implementation of the Component Mode Iteration Algorithm and Singular Valve Decomposition - to be submitted to NASA Langley - Jeffrey Bennighof.

Controller Development for Space Telerobots Having Traction Drive Joints in the Presence of Redundant Kinematics - to be submitted to NASA Langley- Clarence de Silva.

A Policy Support System for Advanced Missions Planning - to be submitted to NASA Langley - Gerald Evans.

Size Distribution of Atmospheric Aerosols - Winston Farrar.

Comprehensive Benchmark Calculations in Galactic Ion Transport - Barry Ganapol.

The Effect of Nonlinearities in the Spacecraft and Controller Configurations - to be submitted to NASA Langley and NSF - Devendra Garg.

Local Stress Analysis in Metal Metric Composites - to be submitted to AFOSR or ONR - Alton Highsmith.

Space Environmental Effects on Polymeric Materials - to be submitted to NASA Langley - Richard Kiefer.

On the Role of Charge-Transfer Complexes in the Laser Initiated Copolymerization of Styrene and Maleic Anhydride in Acetone - to be submitted to NASA Langley - Edmond Koker.

Viscoelastic Fracture Analysis - to be submitted to NASA Langley - Eric Klang.

Spectroscopic and Analysis and Characterization of Group I-III-VI 2 Crystals - George Miller.

Assessment of Verification Strategies for Expert Systems or The Impact of Testing Techniques on Software Reliability. - Larry Morell.

The Aerospace Technician: Learners Today, Leaders Tomorrow - Charles Spellman.

Development of an Optical Displacement Sensing Technique with Micron Resolution - to be submitted to NASA Langley - Ahmad Vakili.

Structural Dynamics and Vibrations of Lightly Damped Systems - to be submitted to NASA Langley - Maurice Young.

In addition to the above there are four Fellows anticipating submittal of proposals to NASA or other agencies.

FUNDED RESEARCH PROPOSALS

Graphics Applications Utilizing Parallel Processing - funded by NASA Langley - Reginald Walker.

Pretreatment of a Platinum/Tin Oxide Catalysts for the Oxidation of CO in a Closed Cycle CO_* Laser - funded by NASA Langley - John Van Norman.

Section VI

SUMMARY OF PROGRAM EVALUATION

A program evaluation questionnaire was given to each Fellow and to each Research Associate involved with the program. A sample of each questionnaire is in Appendix V of this report. Forty-one out of forty-two Fellows responded. The questions and the results are given beginning on the next page.

A. Program Objectives

1. Are you thoroughly familiar with the research objectives of the research (laboratory) division you worked with this summer?

Very much so 26 (63%)
Somewhat 14 (34%)
Minimally 1 (2%)

2. Do you feel that you were engaged in research of importance to your Center and to NASA?

Very much so 37 (90%)
Somewhat 4 (10%)
Minimally 0

3. Is it probable that you will have a continuing research relationship with the research (laboratory) division that you worked with this summer?

Very much so 27 (66%)
Somewhat 12 (29%)
Minimally 2 (5%)

4. My research colleague and I have discussed follow-on work including preparation of a proposal to support future studies at my home institution, or at a NASA laboratory.

Yes 35 (85%) No 6 (15%)

5. What is the level of your personal interest in maintaining a continuing research relationship with the research (laboratory) division that you worked with this summer?

Very much so 39 (95%)
Somewhat 2 (5%)
Minimally 0

B. Personal Professional Development

1. To what extent do you think your research interests and capabilities have been affected by this summer's experience? You may check more than one.

Reinvigorated 20 (49%)
Redirected 18 (44%)
Advanced 27 (66%)
Just maintained 1 (2%)
Unaffected 0

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2. How strongly would you recommend this program to your faculty colleagues as a favorable means of advancing their personal professional development as researchers and teachers?

With enthusiasm 32 (78%)
Positively 9 (22%)
Without enthusiasm 0
Not at all 0

3. How will this experience affect your teaching in ways that will be valuable to your students? (you may check more than one)

By integrating new information into courses 27 (66%)
By starting new courses 9 (22%)
By sharing research experience 34 (83%)
By revealing opportunities for future employment in government agencies 28 (68%)
By deepening your own grasp and enthusiasm 22 (54%)
Will affect my teaching little, if at all 0

4. Do you have reason to believe that those in your institution who make decisions on promotion and tenure will give you credit for selection and participation in this highly competitive national program?

Yes 23 (56%) No 12 (29%)

C. Administration

1. How did you learn about the Program? (please check appropriate response)

13 (32%) Received announcement in the mail.
6 (15%) Read about it in a professional publication.
15 (37%) Heard about it from colleague.
8 (20%) Other (explain). ____________

2. Did you also apply to other summer faculty programs?

Yes 20 (49%) No 21 (51%)

2 DOE
11 Another NASA Center
7 Air Force
6 Army
3 Navy
1 NSA

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3. Did you receive an additional offer of appointment from one or more of the above? If so, please indicate from which.

MSFC - 1 Airforce - 3 Navy - 2
NSA - 1 Another Center - 4 Army - 1

4. Did you develop new areas of research interest as a result of your interaction with your Center and laboratory colleagues?

Many 7 (17%)
A few 31 (76%)
None 3 (7%)

5. Would the amount of the stipend ($800) be a factor in your returning as an ASEE Fellow next summer?

Yes 19 (46%) .Money is not the main consideration.
No 22 (54%) .Didn't participant to get rich.
If not, why .Other objectives are more important than the amount of the stipend.

6. Did you receive any informal or formal instructions about submission of research proposals to continue your research at your home institution?

Yes 26 (63%) No 12 (29%)

7. Was the housing and programmatic information supplied prior to the start of this summer's program adequate for your needs?

Yes 32 (78%) No 5 (12%)

8. Was the contact with your research colleague prior to the start of the program adequate?

Yes 35 (85%) No 4 (10%)

9. How do you rate the seminar program?

Excellent 11 (27%)
Very good 17 (41%)
Good 10 (24%)
Fair 3 (7%)
Poor 0

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10. In terms of the activities that were related to your research assignment, how would you describe them on the following scale?

Check one per Activity	Time Was			
Activity	Adequate	Too Brief	Excessive	Ideal
Research	18 (44%)	8 (20%)	0	16 (39%)
Lectures	24 (59%)	4 (10%)	1 (2%)	13 (32%)
Tours	18 (44%)	13 (32%)	0	3 (7%)
Social/Recreational	22 (54%)	12 (29%)	0	3 (7%)
Meetings	32 (78%)	0	0	6 (15%)

11. What is your overall evaluation of the program?

Excellent 21 (51%)
Very good 19 (46%)
Good 1 (2%)
Fair 0
Poor 0

12. If you can, please identify one or two significant steps to improve the program.

See Fellows' Comments and Recommendations

13. For second-year Fellows only. Please use this space for suggestions for improving the second year.

- A biweekly informal discussion amongst the Fellows may lead to more cooperative activities such as preparation of research proposals to be submitted jointly to NASA for possible funding.
- A written task description mailed 3-6 weeks prior to arrival.
- Work on same kind or similar problems as in first year.
- Probably don't need to attend all the lectures.
- Increase the technical content of ASEE lectures. Inform Fellows of other lectures or series they might attend.

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D. Stipend

1. To assist us in planning for appropriate stipends in the future would you indicate your salary at your home institution.

$__________ per __________.

2. Is the amount of the stipend the primary motivator to your participation in the ASEE Summer Faculty Fellowship Program?

Yes 1 (2%) No 28 (68%) In part 12 (29%)

3. What, in your opinion, is an adequate stipend for the ten-week program during the summer of 1988?

8,000 or more - 13 (31%)
10,000 - 16 (39%)
9,000 or more - 7 (17%)

E. American Society for Engineering Education (ASEE) Membership Information

1. Are you currently a member of the American Society for Engineering Education?

Yes 5 (12%) No 35 (85%)

2. Would you like to receive information pertaining to membership in the ASEE?

Yes 28 No 9

Percentages have been rounded off to next whole number.

Where percentage figures do not equal 100 there was a response missing.

Information on salaries is considered confidential and is not included in this report.

Fifty-four percent (54%) of the Fellows responding indicated that an $8,000 stipend fo the ten weeks in 1987 would be adequate.

Eighty-five percent (85%) of the Fellows indicated that they <u>are not</u> currently members of the American Society for Engineering Education.

FELLOWS' COMMENTS

The comments were as follows: an excellent job of coordination for the program; overall evaluation excellent...; limited technical and clerical support...limits amount that can be accomplished in ten weeks; warn fellows of problem i.e.: working in labs evenings and weekends; the stipend is adequate to provide housing and to cover summer expenses for a family of five. If the NASA/ASEE Summer Faculty Program has more money available, it should be applied towards increasing the number of fellowships; of the programs in which I have been involved none have been run as smoothly and professionally as this one. The program is outstanding, I will be a more effective professor; a painless and effective way to get into some active research; an excellent program, I would attend such a program even if I did not get paid; would like to come on the program for about a year during my sabbatical; would like to explore the possibilities of bringing a graduate student on the program; besides being well organized, the program gives us a message: "The applied sciences are alive and well and here to stay."

FELLOWS' RECOMMENDATIONS

Recommendations included the following: Some additional assistance with locating housing for the fellows; the research time is very short, extend the program to twelve weeks; provide examples of successful grant proposals; provide more opportunities for informal discussion and interaction between fellows; more pre-program contact with research associate; clarify the relationship between the fellow and the research associate; additional technical and clerical support. The stipend is adequate but should be increased to $1,000.00 per week to cover the high cost of living.

There seemed to be a desire for more information on the backgrounds, work interests, and research being done by other summer researchers. Also a desire for more interaction between the Fellows on an informal level.

RESEARCH ASSOCIATES-QUESTIONNAIRE

Most of the responses indicated that the Fellows were adequately prepared for the research assignment. The negative responses were generated by late assignments or by assignments in a totally new area.

All Research Associates responding indicated satisfaction with the diligence, interest and enthusiasm of the Research Fellow. Some indicated that the Research Fellow went beyond what was anticipated for the project.

All Research Associates responding expressed an interest in serving in the program again.

The Research Associates expressed an interest in having the Fellow (where eligible) return for a second year.

RESEARCH ASSOCIATES' COMMENTS

It appears that the program works quite well from my stand point. I have had good luck with all my previous participants.

Having a Research Fellow allowed us to accomplish a project in an area where we did not previously have a capability to accomplish.

Research Fellows are of great assistance.

It would be highly beneficial to the Business Data Systems Division and the Center to allow the Research Fellows to return for a second year to support our implementation program.

Good way to get a short term project done.

The program is and has been excellent - keep the program as is.

Very beneficial for Education Branch to associate with current college professors who represented areas common to our training needs.

RESEARCH ASSOCIATES' RECOMMENDATIONS

Circulate schedule of activities to host branch.

Program could benefit from greater promotion and visibility among all LaRC staff, emphasizing the importance of supporting the Summer Fellow's work with our various skills. Division staff could help by facilitating communications between in-house personnel regarding the fellow's work.

Section VII

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Comments from the Research Fellows and from the Research Associates indicate satisfaction with the program.

Many Fellows indicated the desire for additional informal contact with other fellows as a means for both social and professional development.

Contact with the Research Associate prior to arrival is considered essential.

The stipend is considered to be barely adequate but is not the prime consideration when accepting the appointment.

The program is considered important by the Fellows and Research Associates and should be continued.

RECOMMENDATIONS

Contact by Research Associate prior to arrival to permit previsit consultations.

ASEE program director should communicate directly with the division chiefs regarding the division presentations.

The Fellows recommend considering extending the program to twelve weeks.

Additional technical and clerical support at the branch or division level.

Additional in-house public relations work to promote the program on the site, especially highlighting interdepartmental communications and cooperation.

APPENDIX I

Participants - ASEE-NASA Langley

Summer Faculty Program

Returnees

1987

NASA-ASEE FELLOWS

ODU-NASA LANGLEY

RETURNEES

Fellow	Age	Assigned to	Research Associate
Ms. Ames, Kathy R. Instructor Dept. of Computer Science Virginia Wesleyan College Norfolk, VA 23502	29	Space Systems Division	Joseph M. Price Building 1232 Tel. 865-2885
Dr. Patrick G. Barber Professor Dept. of Natural Sciences Longwood College Farmville, VA 23901	45	Information Systems Division	A. L. Fripp Building 1202 Tel. 865-3777
Dr. Devendra P. Garg Professor Dept. of Mechanical Engineering Duke University Durham, NC 27706	53	Guidance and Control Division	Suresh M. Joshi Building 1268A 865-4591
Dr. Richard L. Kiefer Professor/Chairman Dept. of Chemistry College of William and Mary Williamsburg, VA 23185	48	Materials Division	Sheila T. Long Building 1267 Tel. 865-3892
Dr. Larry J. Morell Assistant Professor Dept. of Computer Science College of William and Mary Williamsburg, VA 23185	33	Information Systems Division	Sally C. Johnson Building 1220 Tel. 865-3681

Dr. Joan G. Sprigle-Adair Assistant Professor Dept. of Child Study Old Dominion University Norfolk, VA 23508	52	Office of Public Services	Mary L. Sandy Building 1192C Tel. 865-3341
Dr. John J. Swetits Professor Dept. of Mathematics and Statistics Old Dominion University Norfolk, VA 23508	44	Flight Electronics Division	Charles E. Byvik Building 1202 Tel. 865-2818
Mr. Robert K. Wattson, Jr. Professor/Asso. Chairman Dept. of Aerospace and Mechanical Engineering Tri-State University Angola, IN 46703	64	Flight Management Division	Roland L. Bowles Building 1168 Tel. 865-3621
Dr. Ahmed S. Zaki Professor School of Business Administration College of William and Mary Williamsburg, VA 23185	59	Business Data Systems Division	Frederick L. Moore Building 1152 Tel. 865-2721

APPENDIX II

Participants - ASEE-NASA Langley

Summer Faculty Program

First Year Fellows

1987

NASA-ASEE FELLOWS

ODU-NASA LANGLEY

FIRST YEAR

Fellow	Age	Assigned to	Research Associate
Dr. Carl M. Andersen Senior Research Associate Dept. of Mathematics College of William and Mary Williamsburg, VA 23185	51	Analysis and Computational Division	John N. Shoosmith Building 1268A Tel. 865-3466
Dr. Jeffrey K. Bennighof Professor Dept. of Aerospace Engineering and Engineering Mechanics The University of Texas at Austin Austin, TX 78712	26	Structures and Dynamics Division	Jern-Nan Juang Building 1293B Tel. 865-2881
Dr. William V. Brewer Associate Professor School of Science and Technology Jackson State University Jackson, MS 39217	48	Information Systems Division	Marion A. Wise Building 1268A Tel. 865-3871
Dr. Thomas A. Carney Assistant Professor Dept. of Meteorology Florida State University Tallahassee, FL 32306	41	Atmospheric Sciences Division	Jack Fishman Building 1250 Tel. 865-2294
Dr. Randall Caton Assistant Professor Dept. of Physics Christopher Newport College Newport News, VA 23606	45	Flight Electronics Division	Charles E. Byvik Building 1202 Tel. 865-2818

Dr. Yi-ling F. Chiang Assistant Professor Computer and Information Sciences New Jersey Institute of Technology Newark, NJ 07102		Trasonic Aerodynamics Division	Mauel D. Salas Building 1192D Tel. 865-2627
Dr. Clarence W. de Silva Associate Professor Dept. of Mechanical Engineering Carnegie Mellon University Pittsburgh, PA 15213	38	Information Systems Division	Walter W. Hankins Building 1268A Tel. 865-3871
Dr. Leon M. Donaldson Associate Professor Dept. of Comprehensive Sciences Morgan State University Baltimore, MD 21239	54	Structures and Dynamics Division	Robert C. Harriss Building 1250 Tel. 865-3237
Dr. Gerald W. Evans Associate Professor Dept. of Industrial Engineering University of Louisville Louisville, KY 40292	36	Systems Engineering Division	Edwin B. Dean Building 1209 Tel. 865-4894
Dr. Winston C. Farrar Professor Dept. of Chemistry Fisk University Nashville, TN 37203	53	Atmospheric Sciences Division	William L. Grose Building 1250 Tel. 865-4788
Dr. Barry D. Ganapol Professor Dept. of Nuclear and Energy Engineering University of Arizona Tucson, AZ 85721	43	Space Systems Division	Lawrence W. Townsend Building 1200 Tel. 865-4223

Dr. Joseph C. Hafele Assistant Professor Science and Math Division Eureka College Eureka, IL 61530	54	Flight Electronics Division	Charles E. Byvik Building 1202 Tel. 865-2818
Dr. Alton L. Highsmith Assistant Professor Dept. of Aerospace Engineering Texas A&M University College Station, TX 77843	28	Materials Division	William S. Johnson Building 1205 Tel. 865-2715
Dr. Thomas R. Huston Visiting Assistant Professor Dept. of Mechanical and Industrial Engineering University of Cincinnati Cincinnati, OH 45221	30	Flight Management Division	Randall L. Harris Building 1168 Tel. 865-3917
Dr. Kakkattukuzhy M. Isaac Assistant Professor Dept. of Mechanical and Aerospace Engineering University of Missouri-Rolla Rolla, MO 65401	39	High-Speed Aerodynamics Division	G. Burton Northam Building 1221 Tel. 865-2803
Dr. Eric C. Klang Assistant Professor Dept. of Mechanical and Aerospace Engineering North Carolina State University Raleigh, NC 27695	30	Structures and Dynamics Division	James H. Starnes Building 1148 Tel. 865-2552
Dr. Edmond B. Koker Assistant Professor Dept. of Physical Sciences Elizabeth City State University Elizabeth City, NC 27909	38	Space Systems Division	Willard E. Meador Building 1200 Tel. 865-4274

Dr. Nenad N. Kondic Professor Dept. of Mechanical Engineering University of Puerto Rico Mayaguez, PR 00708	59	Instrument Research Division	Jag J. Singh Building 1230 Tel. 865-3907
Dr. J. Patrick Lang Associate Professor Dept. of Mathematics Virginia Wesleyan College Norfolk, VA 23502	40	Information Systems Division	Salvatore J. Bavuso Building 1220 Tel. 865-3681
Dr. Calvin W. Lowe Assistant Professor Dept. of Physics and Astronomy University of Kentucky Lexington, KY 40506	32	Flight Electronics Division	Charles E. Byvik Building 1202 Tel. 865-2818
Dr. James T. Luxhoj Assistant Professor Dept. of Industrial Engineering Rutgers University Piscataway, NJ 08854	31	Space Systems Division	L. Bernard Garrett Building 1232 Tel. 865-3667
Dr. George E. Miller, III Assistant Professor Dept. of Chemistry Norfolk State University Norfolk, VA 23504	38	Flight Electronics Division	Antony Jalink Building 1202 Tel. 865-3761
Dr. Mark A. Norris Assistant Professor Dept. of Engineering Science and Mechanics Virginia Polytechnic Institute and State University Blacksburg, VA 24061	26	Interdisciplinary Research Office	Jaroslaw Sobieski Building 1229 Tel. 865-2887

Dr. Ezzatollah Salari Assistant Professor Dept. of Electrical Engineering University of Toledo Toledo, OH 43606	35	Analysis and Computational Division	Donald L. Lansing Building 1268A Tel. 865-2070
Dr. Kenneth Sobel Associate Professor Dept. of Electrical Engineering The City College of New York New York, NY 10031	33	Guidance and Control Division	Jarrell R. Elliott Building 1298 Tel. 865-3611
Mr. Charles G. Spellman Assistant Professor Dept. of Mass Communication Dillard University New Orleans, LA 70122	48	Personnel Division	Frederick M. Thompson Building 1195C Tel. 865-2611
Dr. Ahmad D. Vakili Associate Professor Dept. of Aerospace Engineering and Mechanical Engineering The University of Tennessee Space Institute Tullahoma, TN 37388	37	Transonic Aerodynamics Division	Pierce L. Lawing Building 1212 Tel. 865-4381
Dr. John D. Van Norman Professor Dept. of Chemical Sciences Old Dominion University Norfolk, VA 23508	53	Instrument Research Division	George M. Wood Building 1230 Tel. 865-2466
Mr. Reginald L. Walker Instructor Dept. of Mathematics Hampton University Hampton, VA 23669	29	Analysis and Computational Division	John E. Hogge Building 1268A Tel. 865-3547

Dr. Peter J. Walsh Professor Dept. of Physics Fairleigh Dickinson University Teaneck, NJ 07666	57	Flight Electronics Division	Norman Barnes Building 1202 Tel. 865-3761
Mr. Robert A. Willis, Jr. Assistant Professor Dept. of Computer Science Hampton University Hampton, VA 23664	43	Flight Management Division	Kathy H. Abbott Building 1168 Tel. 865-3621
Dr. Woon-Shing Yeung Associate Professor Dept. of Mechanical and Energy Engineering University of Lowell Lowell, MA 01854	33	Low-Speed Aerodynamics Division	R. Earl Dunham Building 1212 Tel. 865-3611
Dr. Maurice I. Young Professor Dept. of Mechanical and Aerospace Engineering The University of Delaware Newark, DE 19716	60	Loads and Aeroelasticity Division	Raymond G. Kvaternik Building 648 Tel. 865-2661

APPENDIX III

ASEE-NASA Langley Summer Faculty Program

Lecture Series

1987
ASEE/NASA
Old Dominion University - Langley Research Center

LECTURE SERIES

Day: Thursday
Time: 9:00 a.m. to 10:30 a.m.

DATE	LOCATION	TOPIC	SPEAKER
June 4	Bldg 1219 Room 225	Langley Overview	Edwin Prior Technical Assistant Office of Director
June 18	Bldg 1212 Room 200	Ultransonic NDE/ Shuttle Status	Dr. Eric Madaras/ George M. Ware Instrument Research Division/Space Systems Division
July 2	Bldg 1212 Room 200	Space Station	W. Ray Hook Space Station Office
July 16	Bldg 1222	The National Aero-Space Plane	Dr. Sidney Dixon Loads and Aeroelasticity Division
July 23	Bldg 1222	Microburst (Windshear) Research	Dr. Roland Bowles Flight Management Division

Schedule of Final Presentations by Faculty Fellows

Location: Bldg 1219, Room 225
Date: August 6, 1987
Time: 9:00 a.m. to 4:00 p.m.

NAME/DIVISION/BRANCH	TOPIC
Woon-Shing Yeung LSAD/SAB	On Scaling of Airfoil Performance in Heavy Rain Situations
John Van Norman IRD/GRIB	Catalytic Oxidation of CO for Closed-Cycle CO_2 Lasers
Gerald Evans SED/CMD	Evaluation and Selection of SED/CMD Advanced Missions Using the Analytic

	Hierarchy Process and Integer Programming
Ezzatollah Salari ACD/FSGB	Vortex Detection in an Image ACD/FSGB Sequence
Maurice Young LAD/CAB	Structural Dynamics and Vibrations of Lightly Damped Structures: A Method for Preliminary Design Analysis
Robert Wattson FLMD/VORB	Effects of Wind Shear on Airplane Performance
Barry Ganapol SSD/HESB	Benchmark Solutions for the Galactic Ion Transport Equation
Richard Kiefer MD/AMB	Space Environmental Effects on Polymeric Materials
Patrick Lang ISD/SVMB	Mathematical Analysis of Errors in Evaluating Fault Tolerant System Models
Kakkatukuzhy Isaac HSAD/HPB	Modeling Counterflow Diffusion Flame
Kenneth Sobel GCD/AMB	Eigenstructure Assignment for Control of Highly Augmented Aircraft
George Miller FED/ESB	Operation of $Ti{:}Al_{*}O_{*}$ in a MOPA Configuration

APPENDIX IV

ASEE-NASA Langley Faculty Fellows

Abstracts

A General-Purpose Plotting Program

by

Kathy R. Ames

Instructor
Computer Science
Virginia Wesleyan College
Norfolk, Virginia

Researchers frequently find the need to draw plots of their experimental or computational data to facilitate its analysis. Generating such plots by hand can be a very tedious and time-consuming process. Although writing a computer program to automatically generate a plot seems like a reasonable solution to this problem, the tedium of revising the program each time a slightly different plot is desired makes this solution as impractical as plotting by hand. A general-purpose program that could, after a brief interactive question and answer session with a user, selectively extract data from a file that conforms to a predescribed format and generate the requested plot would be a very useful tool. The design and development of such a program was begun during the 1986 NASA/ASEE Summer Faculty Fellowship Program. This year's project has been a continuation of that effort.

The program that was developed last year can accept data in one of three predescribed formats and, with a minimal amount of user interaction, produces on a display screen a "quick and dirty" line plot - i.e., a working version suitable for research analysis but not suitable for reproduction in a technical publication. The primary goal for this year has been to enhance the program so that publication-quality plots can be produced.

The enhanced version of the program maintains the ability to produce a reasonable working plot with very little user interaction. However, several optional features have been added that allow a user to add the necessary final touches that transform a working plot into a production plot. One such feature is user-controlled tic mark labelling. Although the program automatically determines an adequate tic mark interval, this may not always be the most desirable interval. Another new feature is user control over the line pattern and/or symbol used to plot a curve. Although the program automatically uses different line patterns to distinguish multiple curves on a single plot, a symbol plotted at each data point or a combination line and symbol curve may be desired. Finally, a legend, or key, can now be generated and positioned at any point on the plot.

APPLYING KNOWLEDGE-BASED TECHNIQUES TO GRID GENERATION

by

Carl M. Andersen

Senior Research Associate
Department of Mathematics
College of William and Mary in Virginia
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In the last few years artificial intelligence techniques that have been maturing for some time in university environments have begun to gain acceptance in a variety of application areas; and a number of commercial enterprises are now marketing products which originated in artificial intelligence research. One of these areas is the field of knowledge-based systems or expert systems, which appears now to have very wide-spread applications.

The computational approach taken in this discipline is strikingly different from the approach taken in standard scientific computation. In standard scientific computer applications a program is constructed by which the computer is requested to do a set of operations in sequence. First one operation and then the next. In knowledge-based or expert systems the sequence of operations is often not specified or only partially controlled and, as far as the programmer is concerned, is left up to chance. Many languages have been constructed through which expert systems can be constructed. Through such systems human knowledge and experience can be encoded as a set of "rules" which can be gradually updated and improved upon so as to pass the experiences of one expert or perhaps of a team of researchers on to others less knowledgable.

Important successes have appeared, for example, in the realm of medical diagnostics. Another fruitful area may be the control of computer software systems for cases where there is no known algorithm for achieving the desired goals. Different computer programs may be appropriate in different problem domains, but it may take some exploration before the most appropriate approach can be determined. Alternatively, there may be only one computer program but input parameters may need to be adjusted to achieve a desired goal. Many sets of parameter values may be satisfactory. It is not necessary to find a particular set of parameter values; just one of the satisfactory sets. An initial set of parameter values will likely display certain "symptoms" which make those values unsatisfactory. Based on those symptoms the rules will indicate corrections to be made and the system can be run again to look for new symptoms. It is hoped that rules can be designed which will in the first phase advise the user as to how to proceed with adjusting the parameters. In later phases we hope to automate the process so that the knowledge-based system can automatically make calls on the numerical program.

In this project a numerical code (ref. 1) for two-dimensional grid generation for computational fluid dynamics problems has been selected. The input data needed for this code contains many parameters that may be adjusted to achieve a satisfactory grid. Unsatisfactory symptoms include a grid which is too coarse or too fine in particular regions and worse yet a grid in which the wrong lines cross over one another or overlap. A set of rules is being formulated, and encoded in the CLIPS (ref. 2) expert system language, to help the user find parameters which can result in a satisfactory grid for his problem.

1. Smith, R. E.; and Wiese, M. R.: Interactive Algebraic Grid-Generation Technique, NASA Technical Paper 2533, March 1986.
2. CLIPS Reference Manual, Version 4.0, March 1987. NASA Johnson Space Center, Mission Planning and Analysis Division, Artificial Intelligence Section

IMAGE ENHANCEMENT TECHNIQUES APPLIED TO CRYSTAL GROWTH

by

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Current theory emphasizes the role of the shape of the metal-solid interface in the growth of semiconductor crystals. Low Prandtl number materials such as semiconductors are not transparent to visible light, so the traditional visualization techniques to view the interface are not applicable. A procedure to use gamma radiography to visualize the melt-solid interface in the compound semiconductor lead tin telluride was developed at the NASA Langley Research Center in 1985. The procedure was refined and the experiment repeated in the summer of 1987. This procedure involved the use of an Ir-192 radiation source which has radiation capable of passing through the 16mm sample of PbSnTe. The resulting negative is used to prepare a positive print. Although the interface is clearly visible, it is able to be published only with difficulty. To improve the publication quality of the resulting images and to analyze the shape of the interface, image enhancement techniques developed and available at the NASA Langley Research Center were used to digitize and to analyze the interface radiographs. With the techniques the background was removed and the image of the interface was sharpened. Figure 1 shows a sample of the enhanced image.

The image enhancement equipment was also used to prepare a 10-minute movie of the fluid flow that accompanies crystal growth in aqueous solutions. In these experiments visual light was used to record the original image, and the real-time disc was used to prepare the enhanced images. Figure 2 shows one frame from the movie.

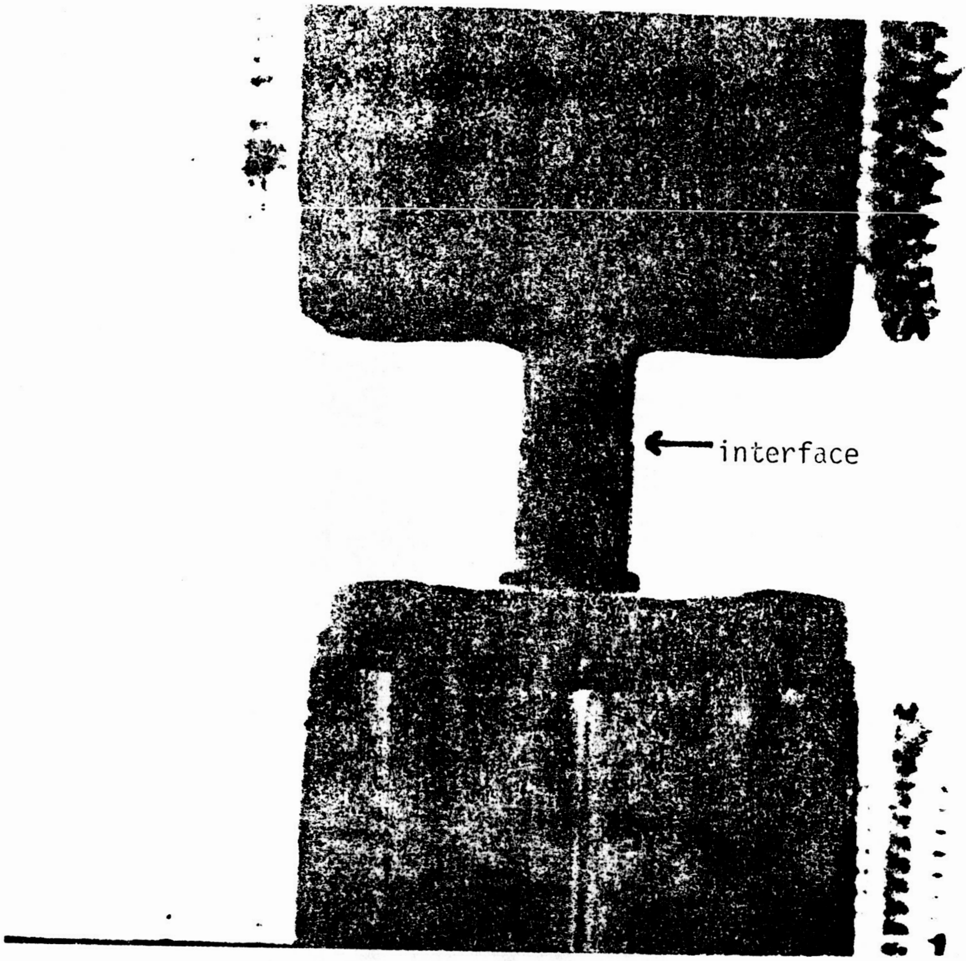

Figure 1a:

Original Radiograph

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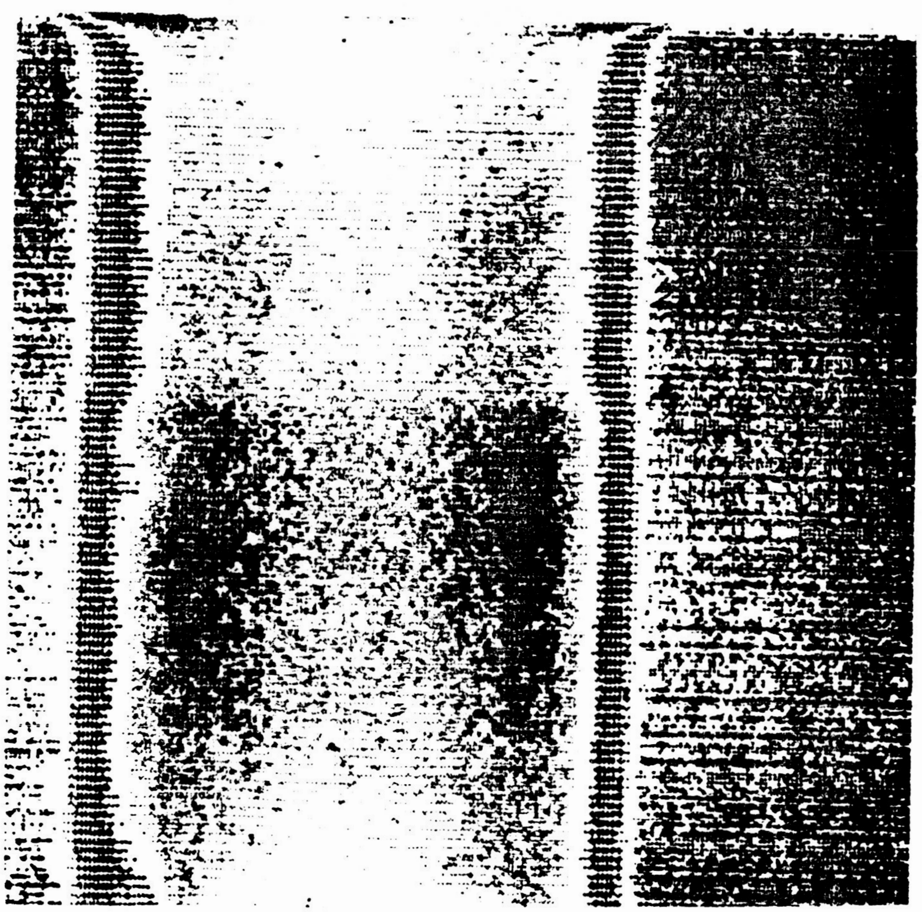

Figure 1b:

Enhanced Image of the Interface Region

interface

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Figure 2: One Frame from Enhanced Movie Showing Fluid Flow During Crystal Growth

Parallel Computation of the Singular Value Decomposition

by

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Austin, Texas 78712

The singular value decomposition (SVD) of a matrix has wide application in control theory and system identification. Of particular interest is its application to the identification and control of flexible structures, which have a very large number of degrees of freedom. A number of proposed identification and control schemes will require the computation of the SVD of a large matrix (with dimensions of several hundred or so) in real time. This will require more computational speed than computers with only a single processor will be able to provide in the foreseeable future, so the ability to efficiently compute the SVD in parallel on a multiprocessor computer will be very desirable.

A significant amount of work has already been done on this problem, so the initial step has been a thorough literature survey. This has revealed that research in applying the systolic array concept to SVD computation has begun quite recently and is already well underway. However, there is still a need for efficient parallel computation of a recursive SVD, and for efficient SVD computation on MIMD computers such as the Flex/32.

This research has also served to illuminate a great deal of potential for SVD applications in the field of structural dynamics. In the few decaeds since Eckart and Young established the SVD for rectangular matrices in 1939, it has found application in more and more disciplines in which numerical analysis plays an important role. These disciplines have included linear algebra, statistics, and in the last eight years or so, control theory. The SVD has only recently begun to be applied to the field of structural dynamics, and it appears that further research is justified in applying the SVD to model order reduction, satisfaction of constraints, and other aspects of analysis and simulation.

END-EFFECTOR PROTOTYPE FOR ROBOTIC ASSEMBLY OF LARGE TRUSS STRUCTURES IN SPACE

by

William V. Brewer
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Current designs for strut-node joints used in space are constrained by the requirement that they must be assembled manually by an astronaut during EVA in the shortest possible time with a minimum number of tools [1]. As a consequence these joints tend to be less compact, more expensive and lack structural stiffness than may be the case when alternative assembly methods are considered.

Robotic assembly of large modular truss structures in space makes it possible to design an end effector interface with the joint such that the task of joining is accomplished more effectively than with manual dexterity.

The objective of our effort is to take advantage of the efficiencies that accrue from designing the end effector and joint components as conjugate pairs rather than trying to design one or the other to fit an existing configuration that was conceived for another purpose.

Time and quantity requirements of the project that will use our design are severe: approximately 250 strut-end assemblies should be available in less than year. These constraints necessitated the selection of a commercially available spherical node as the basis for a first prototype.

The node has threaded holes intended to receive a strut-end having a bolt that is screwed in with a hexagonal drive nut. Incorporating the node "as is" was an expedient but the strut-end design was unacceptable for a variety of reasons.

Criteria governing the first prototype of the end-effector-strut design:

I. Structural performance (reference [2])
   a) axial stiffness maximized (high area cross-sections)
   b) linear force vs deflection response (preload & good contact area between parts)

II. Envelope parameters
   a) 1 in x 2 m strut with 45 degree minimum angle between struts
   b) packaging density maximized (minimum violation of the 1 inch diameter strut envelope and the 66 mm diameter envelope of the node)

III. Robotic constraints

a) 1 g demonstration compatibility (light weight)
b) 2 m plus reach (low force & torque requirement)

IV. Mechanical simplicity
a) parts minimized in both number & kind (especially for the strut)
b) commercially available fraction of part content

Attachment of the strut to the node with a screw thread was accepted with the expedient selection of the commercially available threaded spherical node. Torque and rotary motion must be transmitted from the end effector to the strut to accomplish this. Several drive mechanisms were considered that could provide conjugate pairs to transmit the necessary torque and motion from end effector to strut: cogbelt and wheel, chain and sprocket, bevel gears (drill chuck), spur gears, and worm gears to name a few. The worm gear was selected for further consideration as the best compromise for satisfying the given criteria.

Placing worm gear teeth around the periphery of the driven part of the strut does not increase the envelope nor decrease the cross section area appreciably. Driving the peripheral ring gear with two parallel and tangential worm screws supplies torque without an accompanying force reaction. Drive worm shafts are mounted on jaws that close about the strut to engage the ring and react to the drive torque. The worm drive is permitted to slide axially against centering springs a distance of half a gear tooth before contact with a thrust bearing which initiates the driving force thus greatly reducing the consequence of gear clash on closure.

Attached drawings represent three alternative configurations for a strut end that apply the worm and gear concept described above. A proposed end effector conjugate is also shown mated with a strut end. Details of the simplified version have been prepared for fabrication at LaRC by AMDS.

REFERENCES

[1] Heard, Watson, Ross, Spring, and Cleave: "Results of the ACCESS Space Construction Shuttle Flight Experiment," presented at the AIAA Space Systems Technology Conference, San Diego CA, June 9, 1986, AIAA paper no. 86-1186-CP.

[2] Mikulas, Bush, and Card: "Structural Stiffness, Strength and Dynamic Characteristics of Large Tetrahedral Space Truss Structures," Technical Memorandum, March 1977, NASA TMX-74001, LaRC, Hampton, VA, 23665.

INVESTIGATING ATMOSPHERIC TRANSPORT OF TRACE CONSTITUENTS WITH COMPUTER-BASED MODELS OF ISENTROPIC TRAJECTORIES

by

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Understanding the transport of atmospheric constituents is an essential component to understanding the impact of anthropogenic emissions on our environment and the global climate. The atmosphere has significantly different transport properties within characteristic stratification zones. The many transport models that have been developed are variously effective for the representation of transport in the different layers. Above the earth's boundary layer (1000-2000 m) transport processes are most often regarded as adiabatic, occurring on isentropic surfaces (surfaces of constant potential temperature). Danielsen (1961) introduced new and improved methods of determining isentropic surfaces from standard upper-air pressure and temperature data. Numerous attempts have been made to incorporate these techniques in computer-based models of isentropic trajectories. The most notable attempt included early participation by Danielsen himself and has resulted in the NCAR isentropic trajectory model described by Haagenson and Shapiro (1979). It should be noted that Danielsen feels that no current computer-based isentropic trajectory model adequately translates his subjective techniques for determining isentropic trajectories, mostly objecting to the objective analysis techniques employed (personal communication).

During a previous assignment at the Langley Research Center (LRC), the author worked on adapting the NCAR isentropic trajectory models to the LRC CDC CYBER computers. The objective during this summer fellowship has been to adapt this model to the DEC VAX computer currently used by the LARC Atmospheric Sciences Division for data archiving and analysis. Two different objective analysis schemes to interpolate the radiosonde data to a regularly-spaced grid are being tested and the effect of the alternate schemes on the resulting model trajectories will be evaluated. Although the gridding schemes tested are relatively unsophisticated, this evaluation may help determine if more sophisticated objective analysis techniques are necessary and desirable.

Danielsen, E.F., 1961: Trajectories: isobaric, isentropic and actual. J.Meteor.,18, 470-486.

Haagenson, P. and M.A. Shapiro, 1979: Isentropic Trajectories for Derivation of Objectively Analyzed Meteorological Parameters. NCAR Technical Note NCAR/TN-149+STR. National Center for Atmospheric Research, Boulder, Colorado.

A STUDY OF CONVEX HULL OF SPARSE NONSYMMETRIC LARGE MATRIX

by

Yi-ling F. Chiang
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New Jersey Institute of Technology
Newark, New Jersey

Vortex breakdown is an important phenomenon to be studied in aerodynamics. A tool to study its behavior is finding an approximating solution of Navier-Stokes equation of large Reynolds number. This requires an accurate estimation of the convex hull of a sparse, nonsymmetric square matrix of order around 16,000. Three iterative methods have been investigated to achieve this goal. Due to the size of the matrix, the preliminary concern was the computing time. However, it turns out to be that the accuracy of the estimated convex hull is the main difficulty.

By introducing a shifting factor, the Chebyshev iteration method can be applied to estimate the eigenvalues whose real parts are negative and to manipulate its rate of convergence. Unfortunately, the accuracy of the estimated eigenvalues decreases while the size of the matrix is increasing. The convex hull is estimated randomly; hence, the estimation may not measure the true hull. The generalized conjugate gradient method produces false eigenvalues. Its application creates the problems to identify the true eigenvalues and to construct the convex hull. The Lanczos method has not yet been studied. Numerical results are available. Each method has its own pros and cons. Their special properties should be utilized to be able to successfully estimate the convex hull necessary to study the vortex breakdown problem important in aerodynamics.

PREPARATION OF THE HIGH T_C SUPERCONCUCTOR $YBa_2Cu_3O_X$

by

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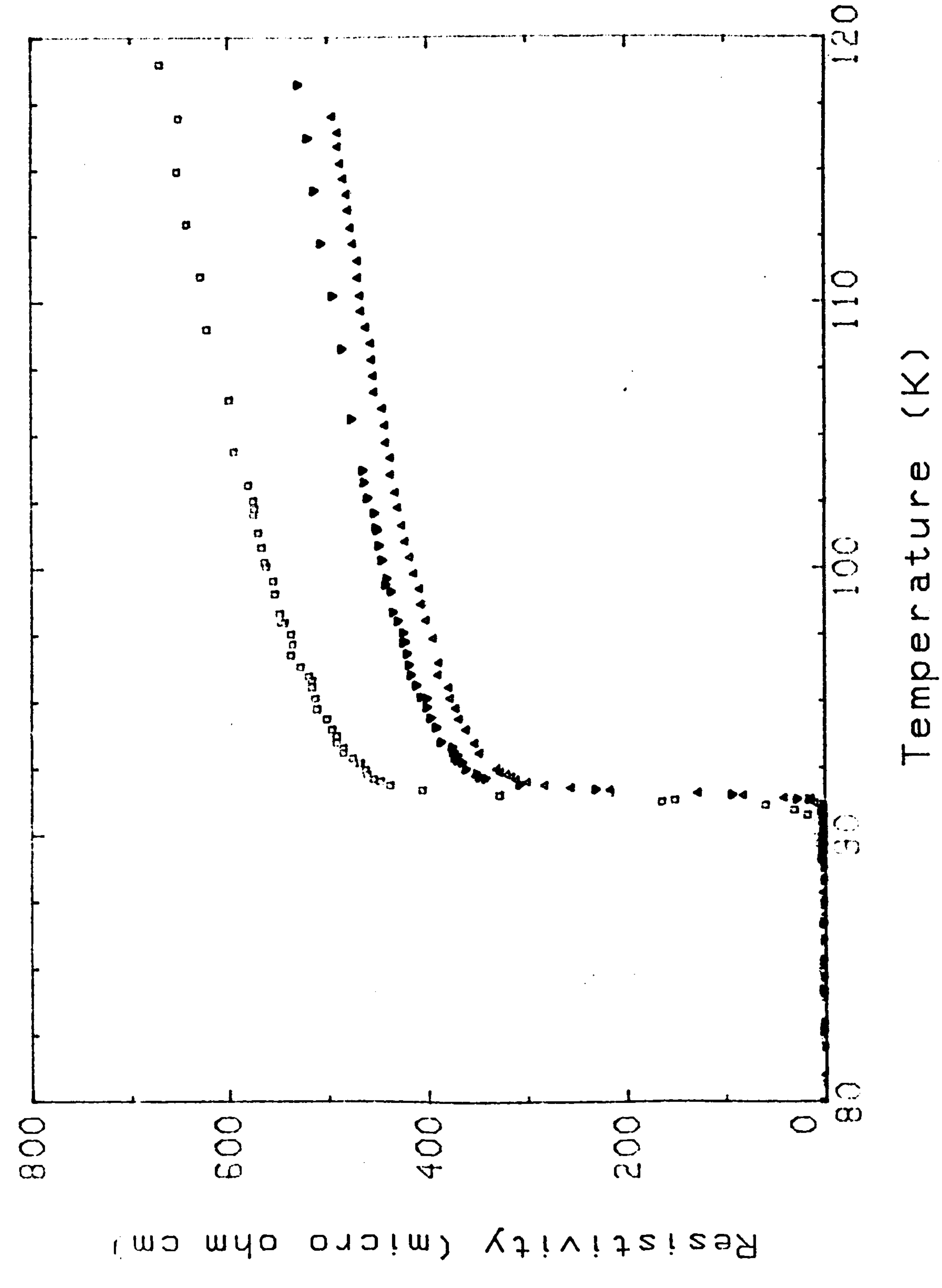
The recent discovery of a new class of ceramic superconductors with transition temperatures above liquid nitrogen has caused a flurry of research activity around the world. The possibilities for application are very exciting if materials with the proper characteristics (eg. high critical currents) can be produced. In particular, we have identified several applications pertinent to research efforts at NASA: sensors in the far infrared region, leads to superconducting magnets, groundstraps to low temperature systems, and magnetic suspension of wind tunnel models. Before these applications can get underway basic research into preparation, characterization, and improving the properties of these ceramic superconductors is required.

The first step is preparation. We are using what is now commonly referred to as the shake and bake method. Appropriate quantities of the starting materials (eg. Y_2O_3, $BaCO_3$, and CuO) are weighed, mixed, and pressed into a pellet. The pellets are then sintered in air at 900°C. This step is repeated after regrinding to increase homogeniety. To produce the final high temperature superconductor the material is treated in oxygen at high temperature after regrinding and pelletizing. We have made several successful samples using this method.

To characterize these materials, we set up to measure resistivity and ac magnetic susceptibility in a closed cycle refrigerator in the temperature range of 20 to 300K. Our best samples show a sharp resistive transition to the superconducting state between 91 and 92K. The ac magnetic susceptibility technique requires modification before proper data can be obtained. When this is accomplished we expect the results to complement our resistivity data.

In order to be useful these ceramic superconductors must have critical current densities several orders of magnitude higher than our curent samples (about $10 A/cm^2$). We are exploring the effect of processing on the superconducting properties. The figure at the end of the report shows the resistivity as a function of temperature for three differently processed samples. The transition temperatures are nearly identical and the critical currents are all about $10 A/cm^2$.

In the coming weeks we plan to pursue studies of the effects of processing in order to produce a better material that can be used for the applications mentioned above. In addition. we plan to explore other materials which might have higher transition temperatures and better properties for applications.


Resistivity (micro ohm cm)
800
600
400
200
0
80
90
100
110
120
Temperature (K)

DYNAMIC EVALUATION OF A TRACTION DRIVE JOINT FOR SPACE TELEROBOTS

by

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Carnegie Mellon University
Pittsburgh, PA 15213

High load capacity/mass ratio, autonomous operation, high accuracy and repeatability, high stiffness, and high dexterity are some of the generally preferred characteristics for robotic manipulators used in space applications. Gear transmission at joints is known to introduce undesirable backlash resulting in low stiffness, and degraded accuracy and repeatability, and high friction with associated high levels of power dissipation and thermal wear problems. Direct-drive manipulation appears to reduce these problems but in this case, manipulator joints tend to be excessively massive. The traction-drive principle developed by NASA promises improvements in this direction, while providing gearless transmission.

A traction-drive joint has two degrees of freedom in two orthogonal directions, a pitch motion and a roll or yaw motion. This nonconventional joint is illustrated in Figure 1. Modeling, analysis, design, and control of robotic manipulators with traction-drive joints are important research considerations. The dynamic model used in the present analysis is represented in Figure 2. This is an eight order model. The model equations have been programmed into the MATRIX_x. The joint response was analyzed for impulse and step inputs under this output feedback servo. Fast and stable response was observed. In particular low rise times and low overshoots were obtained with the output regulator. For example, the pitch angle response to a step input in the absence of the output servo is shown in Figure 3. The response when the output servo is included is shown in Figure 4.

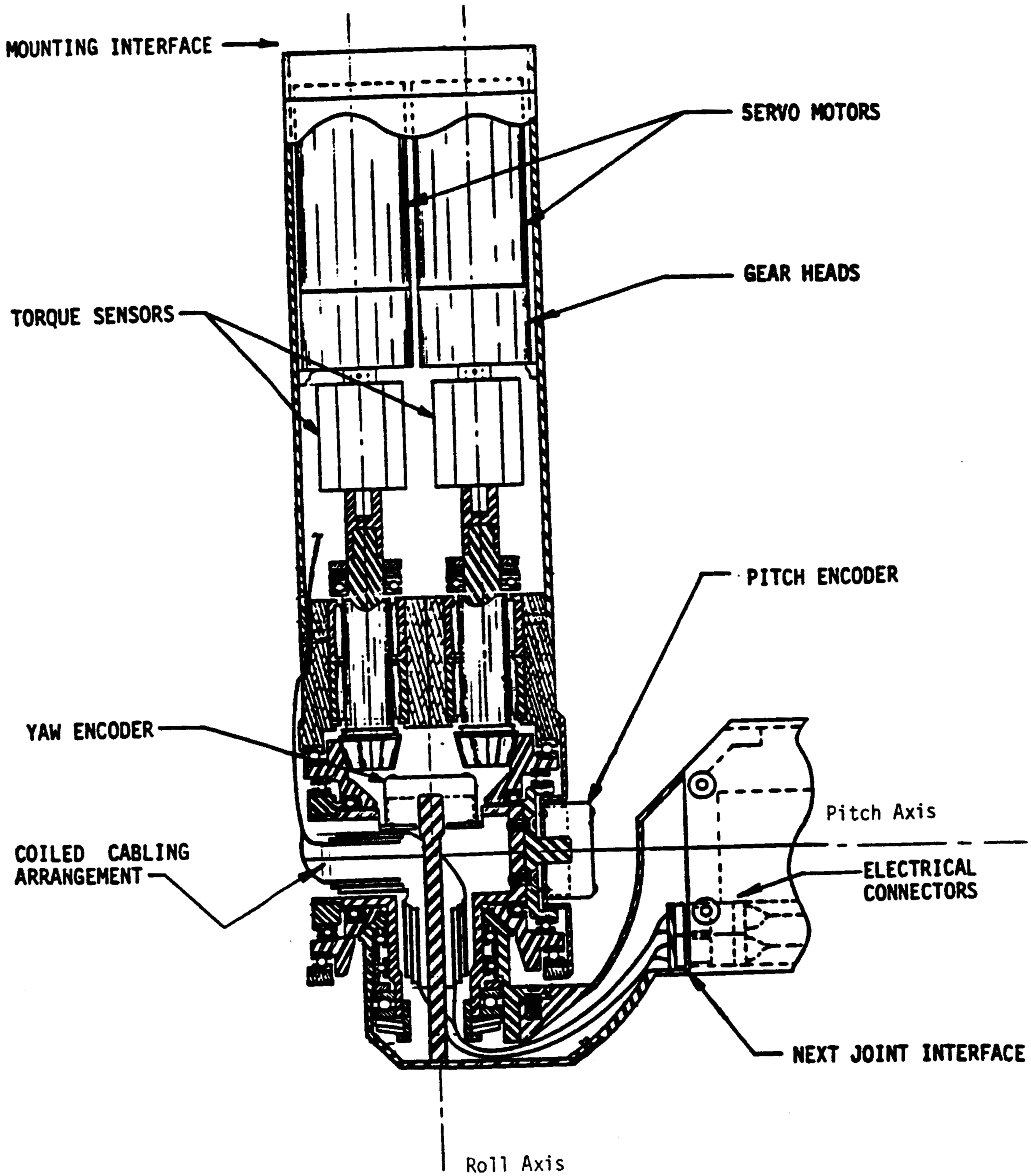

Figure 1. Details of the Traction Joint

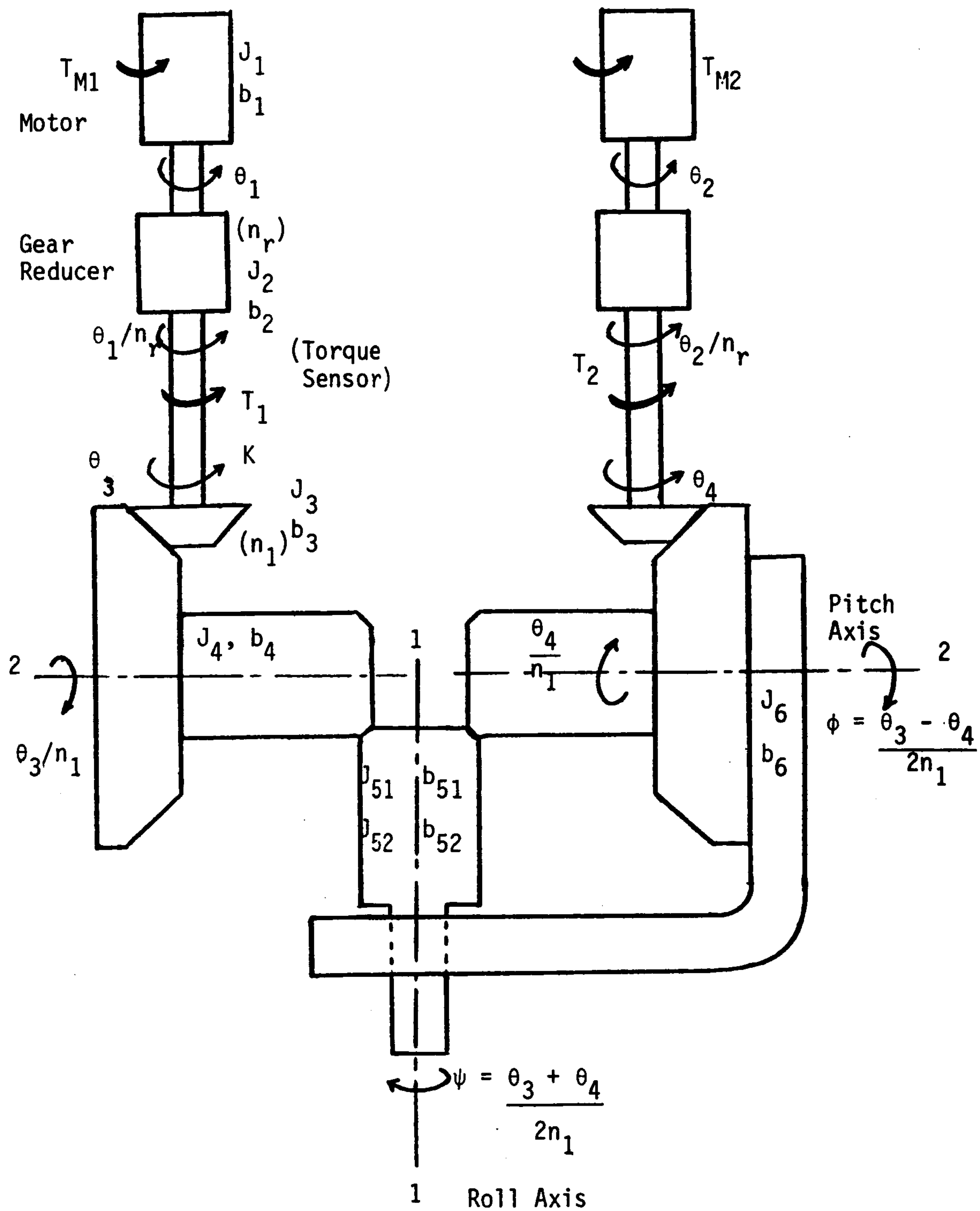

Figure 2.- A Dynamic Model for the Traction-Drive Joint

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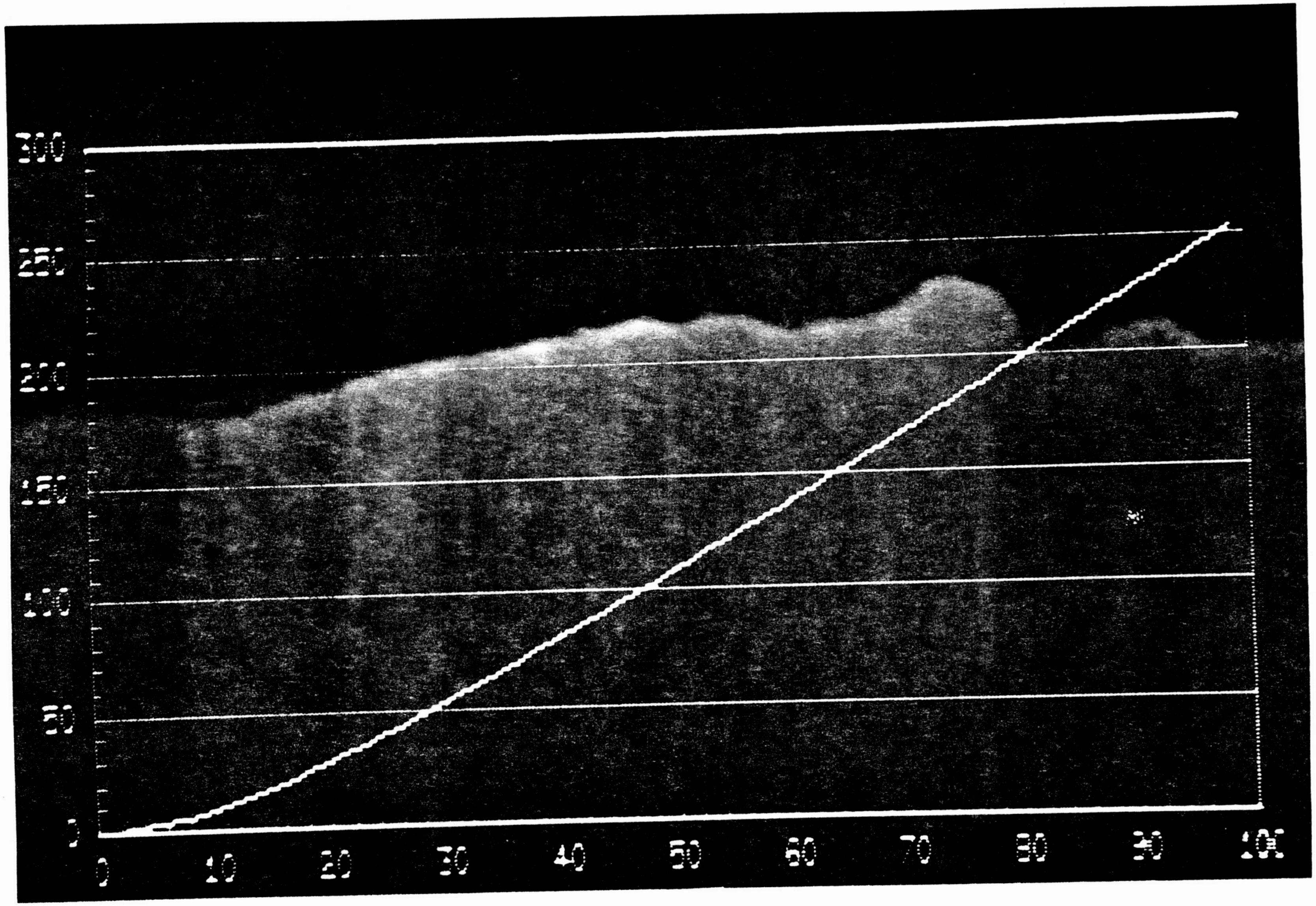
Pitch Angle (radians)



Time (sec.)

Figure 3.- Open-Loop Response to a Step Input

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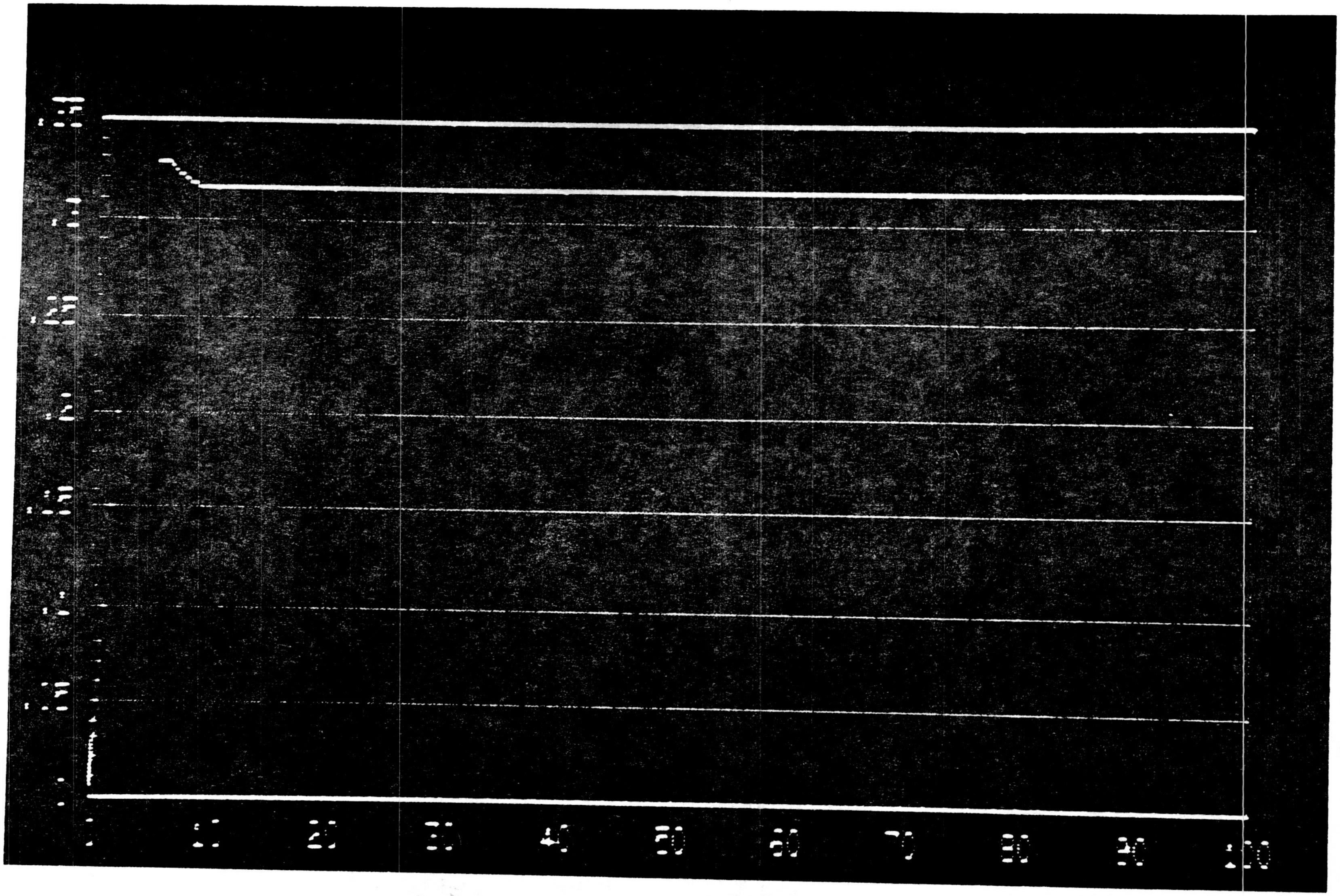

Figure 4.- Step Response Under Servo Control

VARIATION IN ACID DEPOSITION AT A SELECTED SITE IN MARYLAND

by

Leon M. Donaldson
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Morgan State University
Baltimore, Maryland 21239

The troposphere, the lowest region of the atmosphere, which extends from the surface to about 10 to 15 km (6-10 mi depending on latitude) is an area of great chemical activity and diversity (1). Much of the chemical activity emanates from natural sources such as atmospheric lightning, photochemical processes and biogenic activities. However, recent research documents that anthropogenic activities contribute significantly to perturbations of the troposphere through the production and emission of acidic species, such as H_2SO_4 and HNO_3 - (1, 2, 3, 4).

Acidic deposition is uniquely interwoven into the total chemistry of the troposphere. Because of this, a concerted effort between government (through agencies such as NASA, NOAA, NRC, NCAR, and various academic and private establishments has been launched, and is operational, to understand the chemical diversity and processes of the troposphere. (See figure 1) (5).

While other acids of both mineral and organic nature add to the total acid precipitation and subsequent deposition H_2SO_4 and HNO_3 are the primary strong acids controlling rainwater acidity in the industrial regions of the world. The acidification of precipitation by H_2SO_4 and HNO_3 has caused widespread environmental damage in Eastern North America (2).

The problem of acid deposition is regional in nature. Numerous studies have been and are being made to access the impact of acid through precipitation on earth's ecosystems. National and international networks have been established to monitor acid deposition and its effects on the environment.

While much work has been done at regional scales, there is a paucity of research on the temporal variation and potential impacts of acid deposition at specific locations.

The National Atmospheric Deposition Program/National Trends Network (NADP/NTN) operates a precipitation collection site located in Wye (Queen Ann) Maryland. Samples are collected and analyzed on a weekly schedule.

My research is centered around the following:

1. How does acid deposition of the Wye station vary over a time period of several years?

2. What is the relative importance of H_2SO_4 versus HNO_3 as

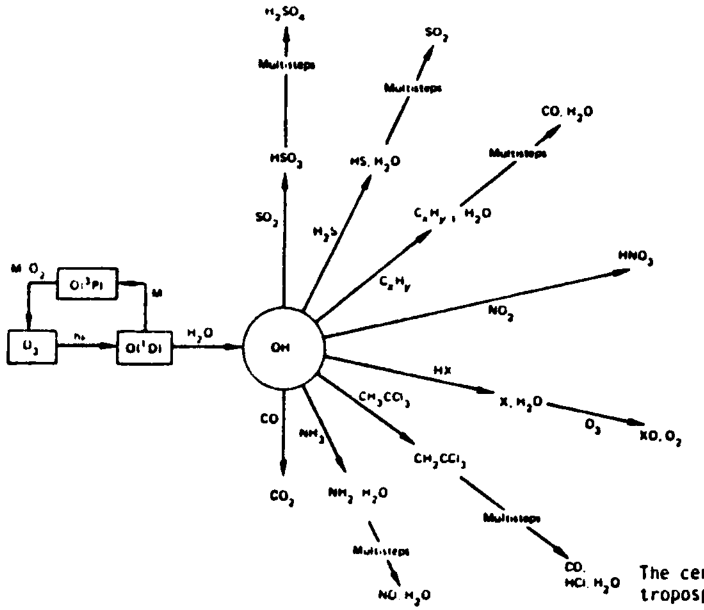
a function of time of year? How does the composition of snow compare to rain?

3. How do data from fine-time collection compare with data from coarse-time collection? (This perhaps will be the result of continuous research).

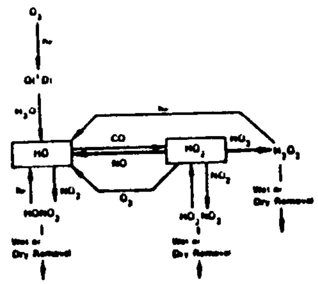
I am in the process of obtaining data sets from the NADP/NTN Coordinator of the Natural Resource Ecology Laboratory domiciled at Colorado State University, Fort Collins, CO, 80523.

This data will be analyzed as to averages, variance, standard deviation, and other statistical concepts.

FIG 1



The central role of OH in the oxidation of tropospheric trace gases.



OH/HO_2 radical chain reactions.

FROM GLOBAL TROPOSPHERIC CHEMISTRY. A PLAN FOR ACTION. GLOBAL TROPOSPHERIC CHEMISTRY PANEL (R. A. DUCE, CHAIRMAN, AND R. CICERONE, VICE CHAIRMAN) PUBLISHED BY THE NATIONAL ACADEMY PRESS, WASHINGTON, DC, 1984.

USING THE ANALYTIC HIERARCHY PROCESS AND INTEGER PROGRAMMING FOR ADVANCED MISSIONS EVALUATION AND SELECTION

BY

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AMIS (Advanced Mission Information System)[2] is an interactive computer-based system being developed to help users in creating and analyzing mission plans (integrated groups of missions). As such, AMIS will contain information on over 1000 Missions to outer space proposed for the time period: 1990-2035. This information includes, for each mission a mission description and objective, benefit categories, precursor and follow-on missions, and estimates of payload weights, schedules, and costs.

Although the AMIS design should provide easy access to mission information by category (e.g., deep space vs. low earth orbit, or international vs. domestic), there are two major disadvantages associated with using the system as a planning tool. First, AMIS does not provide a methodology for the evaluation and ranking of missions (e.g., based upon tradeoffs among benefit categories). Second, the process of integrating missions into a group (i.e., a plan) is tedious at best. In particular, the user must select missions one at a time in developing a plan. Given the large number of missions contained in the data base and the combinatorial nature of the selection process, the problem of grouping missions using this "non-automated selection process" is exceedingly difficult.

The problem associated with the evaluation and ranking of individual missions (or groups of missions) is complicated by the fact that there are several categories of benefits. Many of these categories are difficult to quantify. In addition, the tradeoffs among these categories must be considered in any evaluation process. These complications suggest the use of a technique called the Analytic Hierarchy Process (AHP) ([5]),([6]). AHP basically involves four steps:

1. Development of a hierarchy of factors which affect the evaluation and ranking process (i.e., categories of benefits and costs).

2. Pairwise comparisons among the factors within the hierarchy.

3. Determination of factor weights based upon the pairwise comparisons.

4. Evaluation and ranking of alternatives, based upon the weights determined in step 3.

Example hierarchies and demonstration rankings have been developed, through the use of the Expert Choice software package [1], to illustrate the approach.

As mentioned above, the grouping of missions into plans is a difficult process because of the *large number* of missions contained in the data base and the resulting large number of mission combinations. (For example, with 1000 missions to consider, the number of combinations of missions is 2^{1000}, based upon a go/nogo decision for each mission). In addition, the planning problem is complicated by the existence of budgetary constraints, groups of mutually exclusive missions, potential shifts in individual mission schedules, precursor missions for specific missions, and the inherently conflicting (multiple) objectives associated with the planning process.

A family of 0-1 integer programs has been developed for addressing the planning problem (and therefore accounting for the complications noted above). These optimization models contain decision variables denoted by

x_i =1, if mission i is selected,
0, otherwise.

Any of several objective functions could be considered within the model specified including: 1) the achievement of a specified balance among benefit categories, or 2) maximization of a weighted objective function (value function [3]) over the benefit categories.

Procedures for solving 0-1 integer programs include branch-and-bound with linear programming relaxations (pages 437-446 of [4]) or Balas' implicit enumeration algorithm (pages 467-468 of [4]). Models of a more complex nature (e.g., involving nonlinear objective or constraint functions) many require the use of dynamic programming.

A demonstration of the integer program is being developed this summer. Taking full advantage of the technique's power however, will require a more complete AMIS data base.

1. Decision Support Software, Inc., "Expert Choice Personal Computer Software Library," DSS Inc., McLean, VA copyright 1986.

2. General Research Corporation Memorandum, "Advanced Missions Information System/Initial Operating Capability," September 11, 1986.

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SIMULATION STUDIES OF THE SIZE DISTRIBUTION OF ATMOSPHERIC AEROSOLS

by

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The MODIS program has as one of its aims to obtain observational data on the global distribution and the physicochemcal properties of aerosols. Simulation studies of aerosols are also of interest because they provide a basis for interpreting the measurements and for making predictions in cases where no data is available. Aerosols have a direct impact on climate as well as on hydrological cycles. The size distribution of atmospheric aerosols has been of special interest. Distribution models proposed to date are useful only over a limited range of particle sizes. During the 1969 Pasadena smog study, aerosol particles with diameters in the 0.003 - 6.8 μm range were observed. No existing model is useful over this entire range. We propose to attempt to develop a model which is useful over at least a somewhat wider range of particle sizes than has been previously available. To do this, we shall apply methods similar to those that have been fruitful in the molecular theory of dense gases and liquids.

Studies on frequency distributions in molecular crystals lead to results which are similar to what is observed in a aerosol size distribution experiment. The frequency distributions are obtained using harmonic oscillator functions. We shall also investigate the possibility that these functions will be useful, in a formal way, in this work. Data is available from the October 1985 space shuttle launch on $A\ell_2O_3$ particles with diameters in the 0.1 μm - 10 μm range. We shall compare our prediction with these and other observational results.

BENCHMARK SOLUTIONS FOR THE GALACTIC ION TRANSPORT EQUATIONS

BY

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As mankind turns its attention toward establishing orbiting space stations to serve as bases for future space exploration, the protection of personnel against penetrating radiation has become a relevant issue. In the upper atmosphere and in space, high energy heavy ions called galactic cosmic rays originating in deep space or in our sun are the major ionizing particles. Not only is the unscattered radiation of concern, but also the secondary particles generated from direct nuclear or coulombic fragmentation are responsible for a significant fraction of the absorbed dose. Thus, to ensure the proper shielding of space bases and interplanetary vehicles, predictive dose and flux computational methods must be found. For this reason, NASA has initiated an effort to develop reliable multi-dimensional deterministic methods to analyze proposed shield configurations.

An important component of this effort is the assessment of the accuracy of proposed ion transport algorithums. Partial verification of an algorithum is obtained by comparisons to standard solutions of the governing galactic ion transport (GIT) equations. These solutions, referred to as benchmarks, are highly accurate evaluations for simplified transport problems which, nevertheless, contain the relevant physical features of the basic transport processes. The motivation behind these comparisons is that algorithms developed for realistic situations must also give reliable results for the simple problems as well.

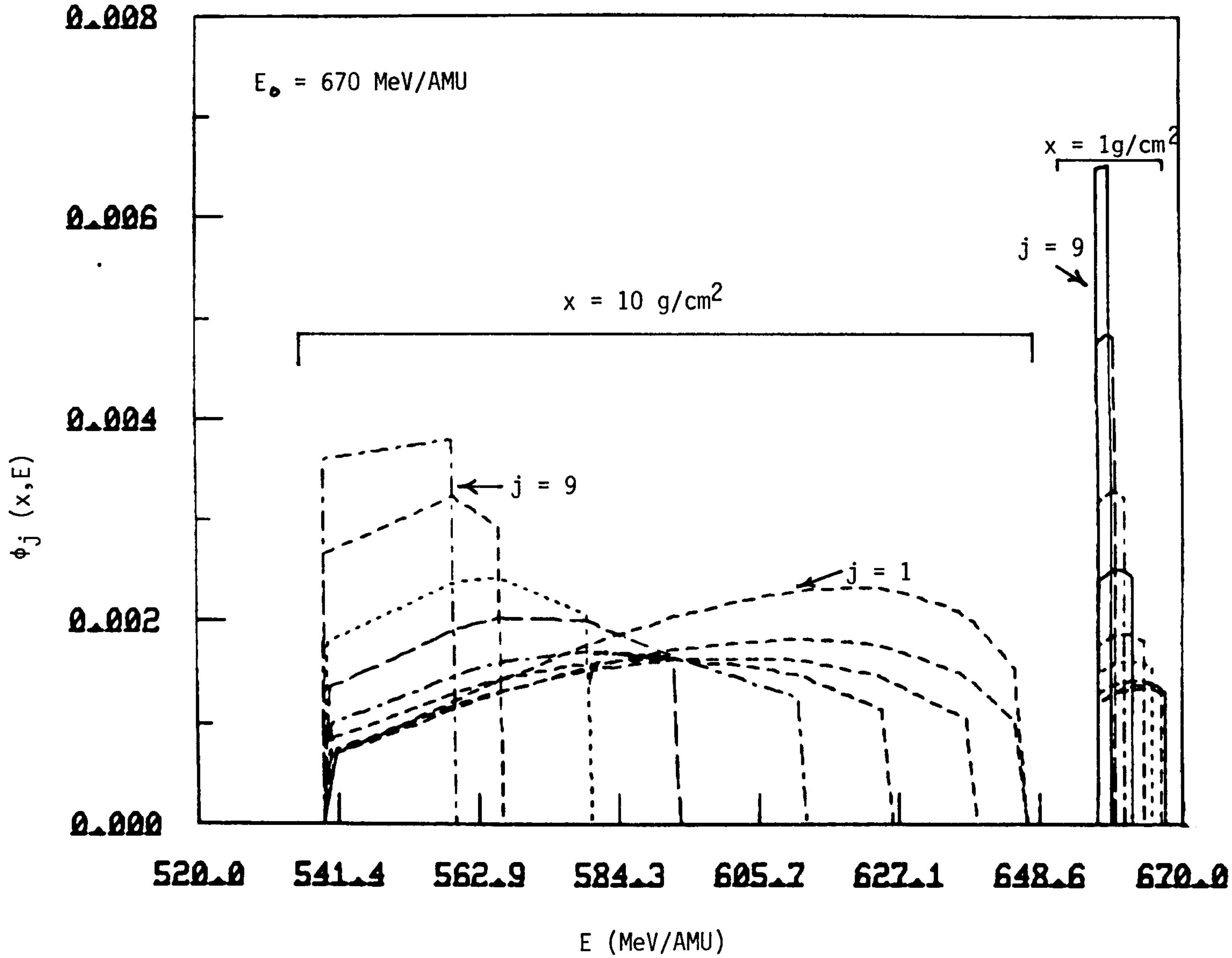
Because of the high energy of galactic ions, deflection of the ions upon collision can be neglected and the straight ahead approximation can be assumed. With this and the continuous slowing down approximation, the appropriate transport equation for ions of charge j is

$$\left[\frac{\partial}{\partial x} - \frac{\partial}{\partial E} S_j (E) + \sigma_j (E) \right] \phi_j (x,E) = \sum_{k=j+1}^{J} m_{j,k} \, \sigma_k (E) \, \phi_k (x,E)$$

where ϕ_j is the jth ion flux at position x (from the source) with energy E(MeV/AMU) The GIT equations are solved in three levels of difficulty-energy independent, spatially independent and finally with spatial/energy coupling. The methods of solution emphasize analytical techniques never before applied to the GIT equations. As a result, a fully analytical solution has been established for the GIT equations with spatial/energy coupling and constant transport properties.

Figure 1 shows the energy spectra for ions j = 1,2 . . .9 for neon (j = 10) incident at 670 MeV/AMU on a semi-infinite air atmosphere. The spectra are shown at two positions, x = 1 and 10g/cm^2. This figure presents the first results for the GIT equations without numerical approximation to be used as a transport benchmark.

Figure 1. Flux variation with energy



ROBUST CONTROL STRATEGIES FOR LARGE SPACE STRUCTURES

by

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Large space structures include a variety of configurations ranging widely from a single rigid body carrying flexible appendages, to extremely huge satellites. Such structures are commonly used for communications, power generation, surveillance, space exploration, and astronomy related investigations. The structures are modeled as distributed parameter systems having an infinite dimension. However, in practice the structures are described by high-order state space or finite element models. Their common characteristics include a number of closely spaced, low resonant frequencies, small inherent damping, and stringent orientation, vibration suppression, alignment accuracy, and shape retention constraints.

An active control of large space structures is generally achieved through a variety of sensors and actuators located along the structure and operated by an on-board computer. Appropriate control laws are designed to satisfy performance requirements such as closed-loop stability, pointing accuracy,and disturbance rejection. A standard procedure in use is to base the controller design on a reduced-order plant model which incorporates the essential dynamics of the overall plant. However, a reduced-order model can result in a control and observation spillover due to a coupling of control and measurement energy between the control system and neglected plant subsystem. The spillover can lead to performance degradation or even plant destabilization.

Robust controller design techniques such as the Linear-Quadratic-Gaussian (LQR) method coupled with the Loop Transfer Recovery (LTR) approach, and the output feedback method using collocated sensors can be gainfully employed in the presence of modeling uncertainties and sensor/actuator nonlinearities. The design is carried out in the frequency domain and regions of stability are identified.

The research effort during the Fellowship period this summer included a review of recent publications pertaining to the dynamics and control of large space structures. This primarily consisted of technical conference proceedings and journal articles. A seminar entitled "Controller Synthesis for Nonlinear Systems" was presented under the sponsorship of the Spacecraft Control Branch, Guidance and Control Division. The seminar was widely publicized by the Branch and was attended by researchers from other Divisions as well. In addition, a week-long "ICASE Workshop on Control and Identification" was attended and actively participated in. A critical review of a contractor report on the dynamics of SCOLE slew maneuvers was performed. The presence of nonlinear effects, both in the dynamic model of the space structure and the sensor/actuator characteristics, can significantly degrade system performance. Effort is continuing to investigate relevant techniques for design of robust optimal controllers in the presence of such nonlinear phenomena.

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Laser Clocks: Design Considerations and Potential Applications in Aerospace Research

by

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Recent advances in solid-state laser technology appear to have established the basis for frequency and time standards in the optical region. Compared with currently available microwave standards, solid-state lasers are expected to provide better frequency stability and time resolution as well as a significant reduction in size and cost. The frequency stability for laser oscillators, when combined with emerging trapped ion spectroscopy, is expected to approach 1 part in 10^{18}, which is at least 10,000 times better than currently available cesium beam standards. This level of frequency stability would permit several new tests of Einstein's General Theory of Relativity.

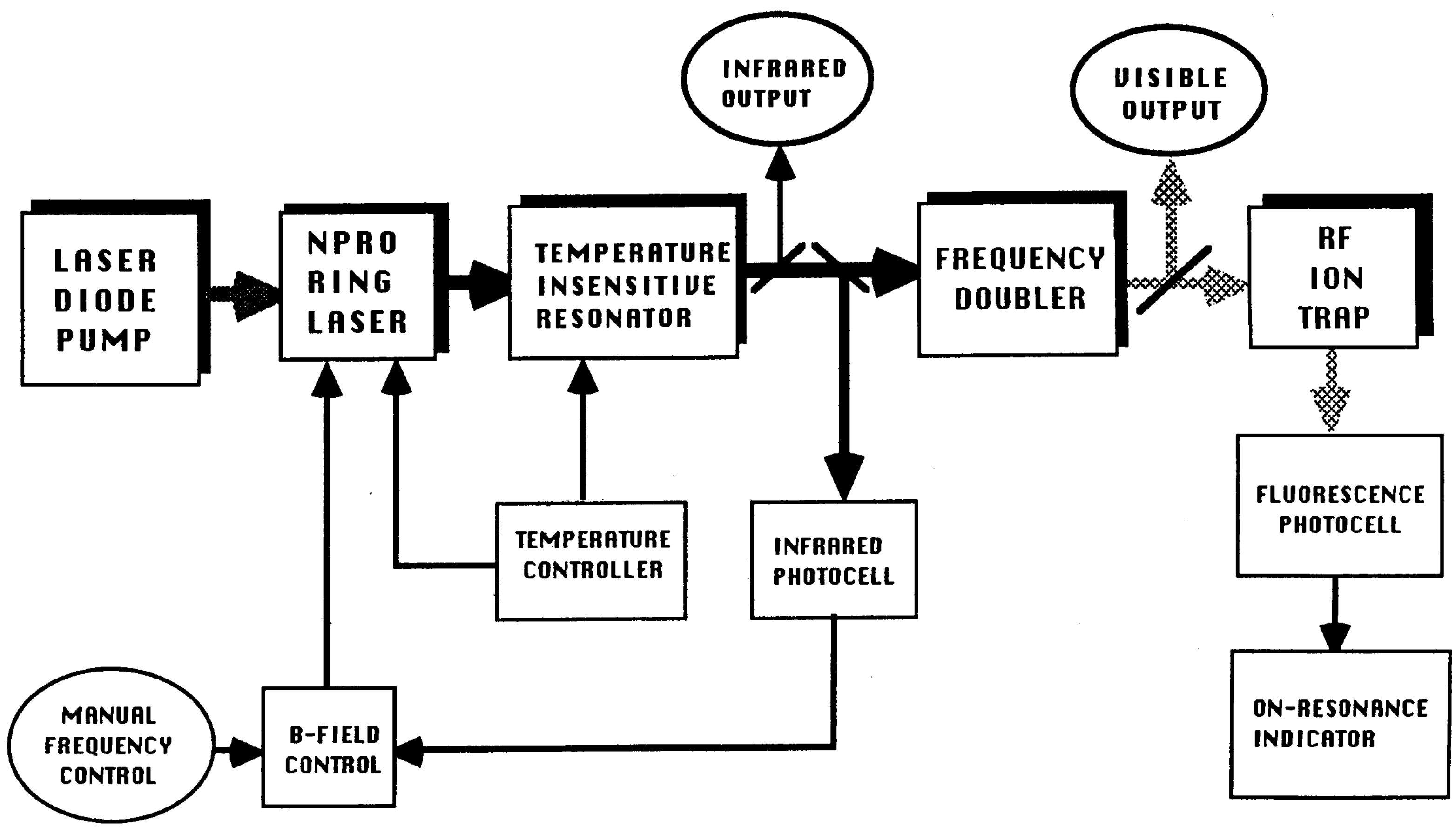
Figure 1 shows the current vision for a laser based frequency standard, which consists of 5 stages. Each successive stage improves the frequency stability from the previous stage. The heart of the system is the Non-Planar Ring-Oscillator (NPRO), which produces highly stable infrared radiation. A test of NPRO lasers in the vibration and noise free environment of space, SUNLITE (Stanford University - NASA Laser In Space Technology Experiment), is expected to produce a linewidth of about 1 Hz (about 1 part in 10^{15}). Much work beyond this test will be needed to fulfill all the necessary details for the plan of Figure 1. However, we have been unable to identify any technically impossible hurdles.

Clocks with a frequency stability and resolution on the order of that anticipated for NPRO ring lasers could be used to make two new tests of Einstein's General Theory of Relativity, namely to detect gravitational radiation and to detect the dragging of inertial frames near large rotating bodies. A 1 million km orbiting interferometer that utilizes NPRO lasers to detect gravity waves has been proposed. Another application for NPRO lasers would be detection of the drag of inertial frames near the Earth. The Kerr metric of General Relativity predicts a difference in the speed of light with and against the Earth's rotation of about 1 part in 10^{13}, which is comparable with the frequency stability for NPRO frequency standards. Several experiments to detect inertial frame dragging near the Earth have been conceived and evaluated. Figure 2 shows a concept to test for inertial dragging that involves three equally spaced geosynchronous satellites.

Another application for ultrastable laser clocks would be to test the inverse square law for gravity, which has been cast in doubt recently by measuring g in deep Australian mines.

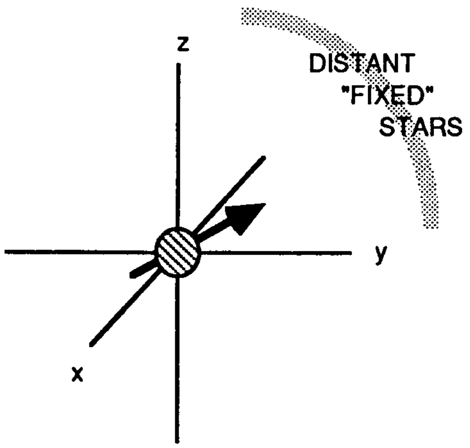
LASER FREQUENCY STANDARD

SYSTEM SCHEMATIC DIAGRAM



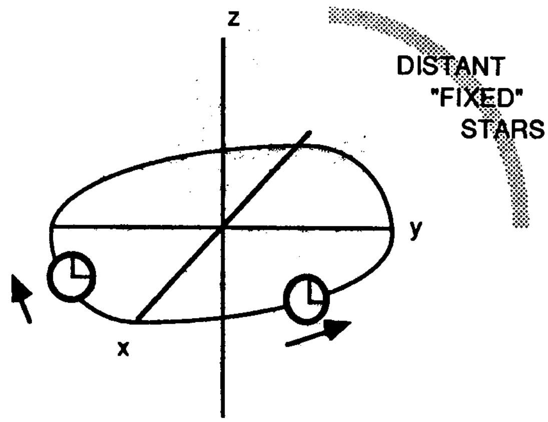
ROTATION DETECTION TECHNIQUES

MECHANICAL
(gyroscope)



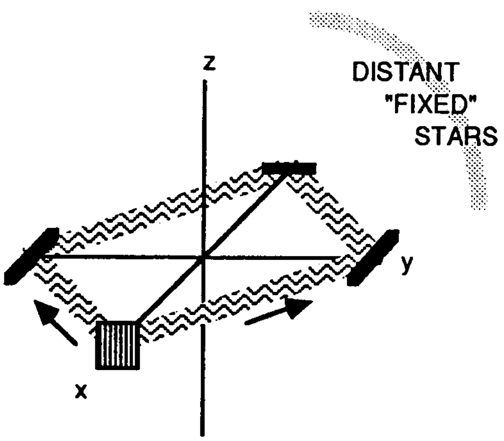
Orientation of the spin axis of a rotating object remains fixed relative to a nonrotating (inertial) system of reference.

TEMPORAL
(USNO around-the-world clocks)



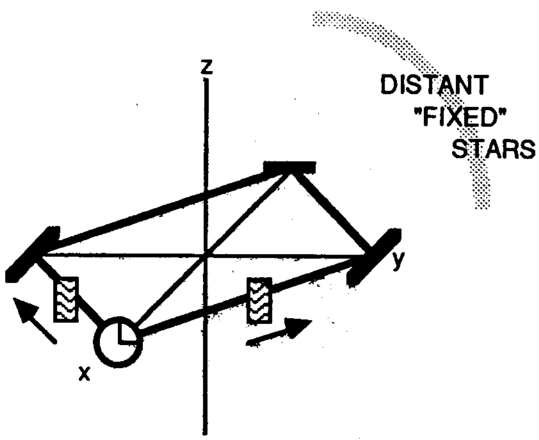
The times recorded by two identical clocks that traverse the same open path in opposite directions are equal in a nonrotating (inertial) system of reference.

OPTICAL
INTERFERENCE
(sagnac)



The interference fringe pattern for two coherent light beams that have traversed an open loop path in opposite directions remains stationary in a nonrotating (inertial) system of reference.

OPTICAL PULSE
(NBS around-the-world)



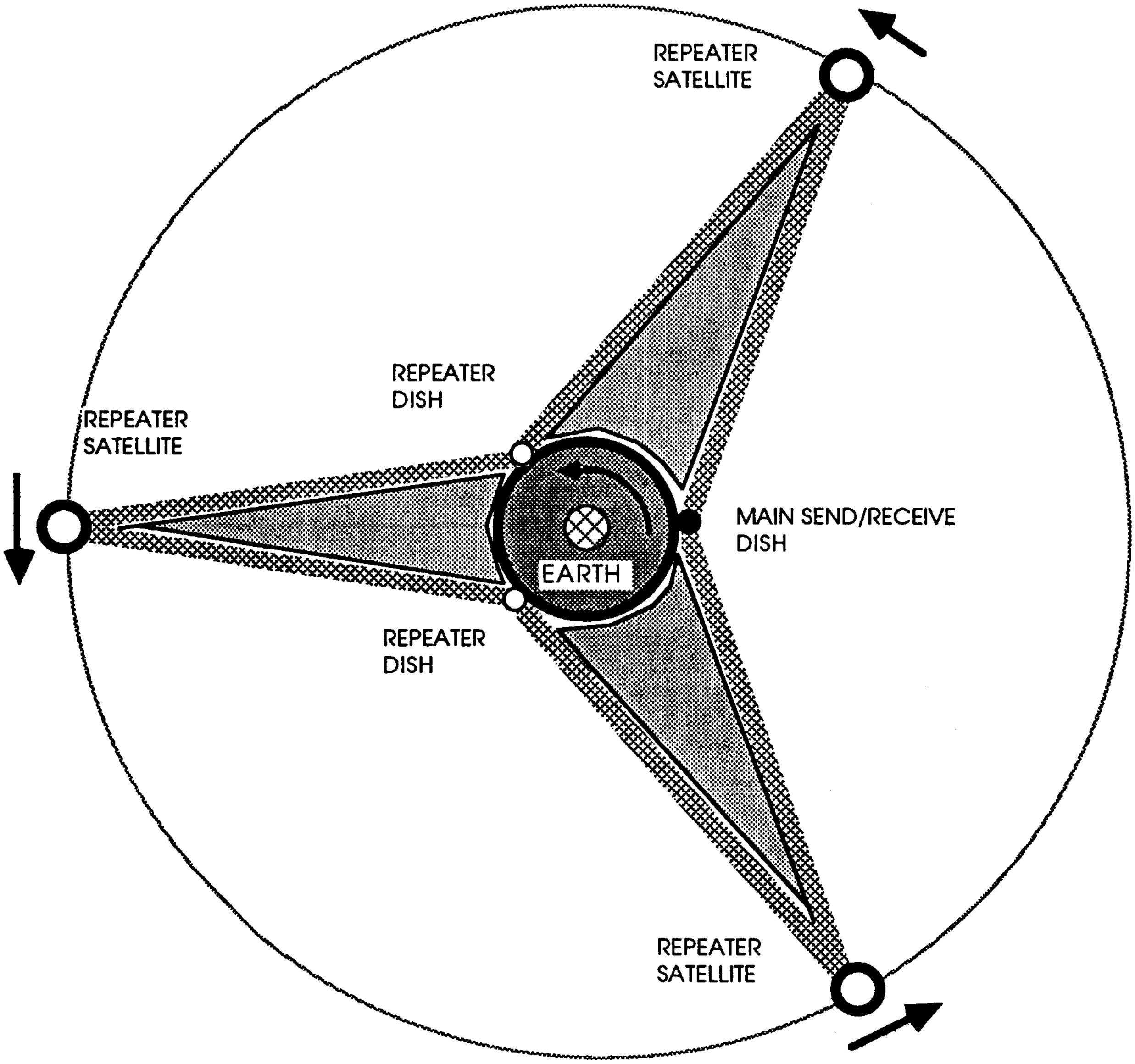
The times for two pulses of light to travel around an open loop path in opposite directions are equal in a nonrotating (inertial) system of reference.

Large Scale Sagnac Test

Geosynchronous repeater satellites in equatorial plane

Equally displaced communication dishes

Sagnac time difference proportional to enclosed area



Fiber-Matrix Separation in Silicon Carbide/Titanium Metal Matrix Composites

by

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Abstract

The effort to develop a single stage to orbit vehicle has motivated considerable research into the development of new materials. Travel at hypersonic velocities requires materials which can sustain structural loads while subjected to extreme temperatures. Metal matrix composite materials are among the candidate material systems under consideration for use in such vehicles. The present study is an evaluation of one such material system.

The material system studied in this investigation consisted of a titanium (Ti 15-3-3-3) matrix reinforced by continuous silicon carbide (SCS6) fibers. Room temperature quasi-static tension tests were performed on matrix material, and on $[0]_8$, $[90]_8$, $[0/90]_{2s}$, $[0/\pm45/90]_s$, and $[0_2/\pm45]_s$ composite laminates in order to evaluate an existing elastic-plastic model which had successfully predicted the response of other metal matrix systems. Initial moduli and Poisson's ratios were in reasonable agreement with those predicted by the model. However, the laminates containing off-axis plies exhibited non-linear mechanical response at stress levels which were significantly lower than the onset of yielding predicted by the model.

In order to document damage development in the laminates, edge replication, a technique in which a permanent impression of the specimen edge is produced in a cellulose acetate film, was used. Edge replicas were taken at various stages of the quasi-static load history of a specimen, and were subsequently examined via scanning electron microscopy. It was found that after sufficient load was applied to specimens containing off-axis plies, fibers began to separate from the matrix material. Upon unloading, the fiber and matrix were again in contact.

The attached figure shows a representative stress-strain curve for a $[0/90]_{2s}$ laminate which was reloaded after fiber-matrix separation had occurred. The micrograph at the left shows the fiber and matrix in contact at low stress, while the micrograph at the right shows evidence of separation at high stress. The "knee" in the stress strain curve is indicative of the loss of stiffness that occurs when fibers in off-axis plies are no longer in contact with the matrix, and therefore no longer carry load. A thermoelastic analysis indicates that there are residual stresses developed during the curing process that must be overcome before the matrix can pull away from the fiber.

The results of this study indicate that the fiber-matrix interface in the silicon carbide/titanium system is quite weak. Separation between the fiber and matrix occurs at relatively low stresses, and the properties of the composite are compromised. Improved bonding between fiber and matrix is needed before this material system will be useful for high performance aerospace structures.

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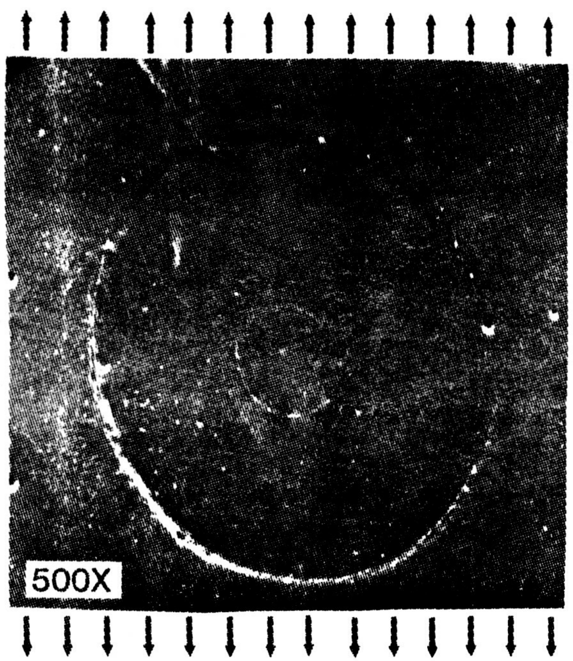
FIBER/MATRIX INTERFACE FAILURE

SCS-6/Ti-15-3

[0/90/0/90]s



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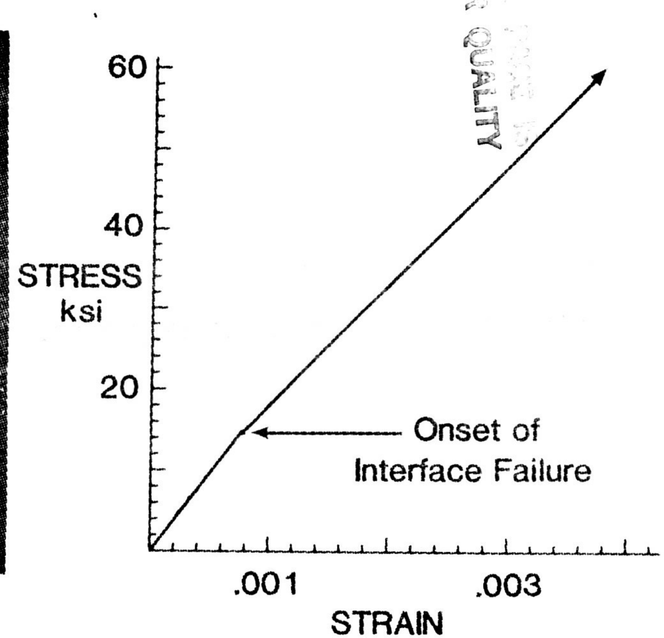

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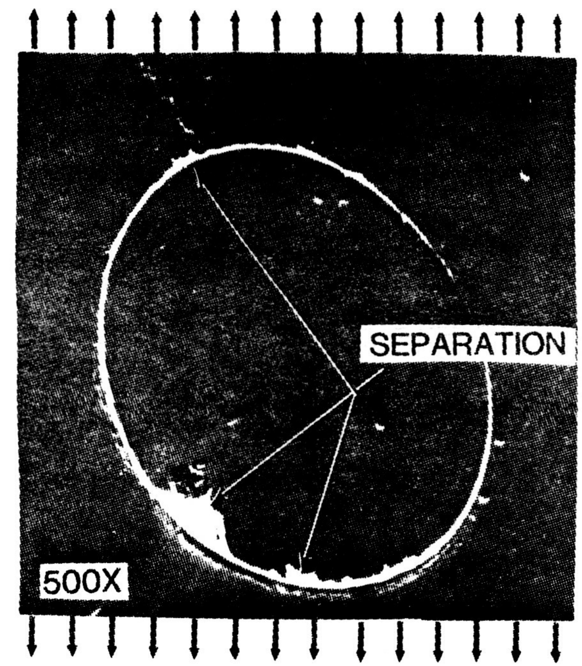

60 KSI

A HUMAN FACTORS COMPARISON OF ADVANCED DIGITAL DISPLAYS

By

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Digital displays are increasingly being used in the cockpit of modern aircraft. The appeal of digital displays is the potential enhancement in the accuracy and resolution of information that is transferred to the pilot. Past research has suggested that digital displays are superior to analog displays for certain measurements. However, there has been little research to compare different types of digital displays, from a human factors perspective.

This research compared the use of two of the more common digital displays used in advanced technology--cathode ray tube (CRT) and light emitting diode (LED). This comparison was completed by the use of 20 subjects in a repeated measures experiment. The primary task of the experiment was the interpretation of a three digit value from on the digital display. The values on the digital display were determined by a random number generator and were visible for 30 msec within a two second time interval. If the value on the display was below 247, the subject was instructed to depress a hand-held button.

Thus one response variable was the elapsed time from the presentation of the value on the display to the activation of the hand-held button. This response time was divided into recognition time and decision time by the calibration of the subjects´ reaction times. A second response variable was derived by monitoring the subjects´ electroencephalogram (EEG). Specifically, the EEG was observed for a brief period (900 msec) following the presentation of the values on the digital display. Such an observation is commonly referred to as the "evoked potential".

The evoked potential was analyzed by a conventional approach. In short, the amplitude of the peaks and valleys of the waveform were measured along with the latency of these peaks and valleys.

In addition to, the comparison of the CRT versus the LED display types, the response variables were analyzed for differences in the display values presented on the digital displays. Specifically, the display values were banded into three groups, 0-99, 100-199, and 200-247 for comparison purposes. To unveil similarities between the two response variables, a correlation analysis was utilized.

The results failed to indicate a marked difference between the LED and CRT for overall response time. However, when the response time was divided into recognition and decision time, there were significant differences between the display types. There were also significant differences in the evoked potential between the digital display types. The display value factor was significant for both the response time and evoked potential. The correlation analysis yielded highly significant results indicating a possible relationship between the response times and the latencies of the peaks within the evoked potential.

MODELING OF COUNTERFLOW DIFFUSION FLAME

By

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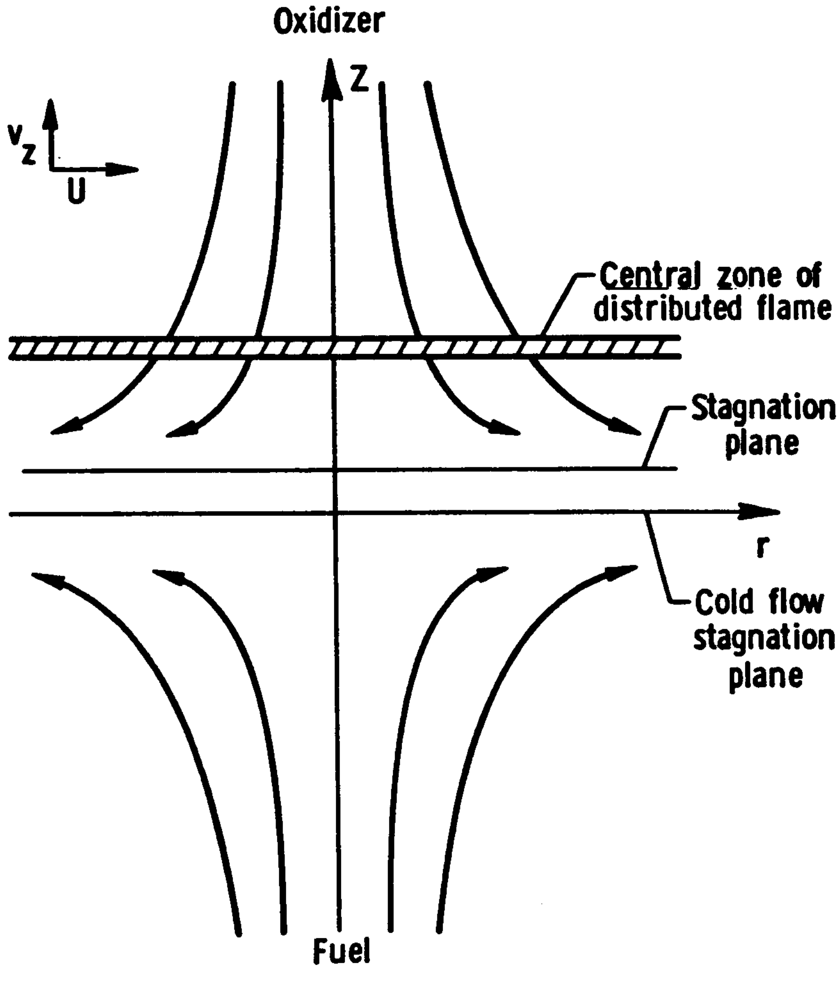
The recent resurgence of interest in the National Aerospace Plane has necessitated the investigation of fundamental phenomena underlying supersonic combustion of hydrogen. One of the problems of interest is the effect of vitiation of test media on combustion characteristics. In order to interpret the results from wind tunnel tests and relate them to flight conditions, it is necessary that the effect of vitiation on chemical kinetics, thermodynamic and transport properties and flame stability be accounted for.

An attractive experimental setup for the study of diffusion flames is the opposed jet burner (OJB) shown in the figure. A fuel jet and an oxidizer jet emerge from tubes of equal diameter and create a stagnation point flow as shown in the figure. A diffusion flame forms in the viscinity of the stagnation point under favorable conditions. As the conditions are varied, blowoff, characterized by the disappearance of the flame from the central zone, occurs and the flame assumes a torroidal shape. As conditions are reversed, the flame restores to the central zone. However, experimental results show a hysterisis effect as the flame undergoes blowoff and restore.

The purpose of modeling this flame has been to develop a suitable model to predict the phenomena observed in experiments. A boundary-layer analysis can reveal many of the observed phenomena. The continuity and momentum equations are written in cylindrical coordinates and the usual boundary-layer approximations are carried out. These equations are then transformed into a single third order ordinary differential equation by means of a Howarth-Dorodnitsyn type similarity transformation. The energy equation and the species continuity equations can also be transformed into ordinary differential equations. The resulting set of ordinary differential equations can be solved by the damped Newton's method for multipoint boundary-value problems. The energy and the species continuity equations are solved by the time dependent Newton's method which enhances the diagonal dominance of the Jacobian matrix and improves convergence. The weak coupling of the fluid dynamics and the chemical kinetics affords partial decoupling of the fluid dynamics equation from the rest of the equations for the purpose of the numerical solution of the equations.

Preliminary results indicate rapid convergence to specified tolerances.

AXIAL-RADIAL FLOWFIELD FOR OJB COMBUSTION



SPACE ENVIRONMENTAL EFFECTS ON POLYMERIC MATERIALS

By

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Polymer-matrix composites have considerable potential for use in the construction of orbiting structures such as the Space Station and space antennas because of their light weight, high strength, and low thermal expansion. However, they can suffer surface erosion by atomic oxygen in low-Earth orbit, and degradation and/or embrittlement by electrons and ultraviolet radiation especially in geosynchronous orbit. Thus, a study of the effect of these environmental hazards on polymeric materials is an important step in the assessment of such materials for future use in space.

Atomic oxygen, which is the major atmospheric component in the low-Earth orbit, is chemically very reactive. It can be generated in the laboratory by subjecting molecular oxygen at low pressure to radio-frequency radiation. In our study, atomic oxygen was generated in a chamber 4 inches in diameter by 6-inches long kept at a pressure of 200 millitorr. So that the products of the reaction of polymeric materials and atomic oxygen could be identified, three U-tubes were placed in the line between the chamber and the vacuum pump. The first tube was immersed in a dry ice/acetone bath, while the other two were immersed in liquid nitrogen. After a sample was exposed to atomic oxygen, the contents of each tube was analyzed separately by warming the tube to room temperature and transferring the contents to a gas cell. The products were identified by infrared spectroscopy. In all cases, the first tube contained water (H_2O), the second tube contained carbon dioxide (CO_2), and the third tube had no measurable product. Polyimides also formed nitrogen dioxide (NO_2) and polysulfone formed sulfur dioxide (SO_2). In both cases, the extra product was found in the second tube. No other products could be identified, implying that the interaction of atomic oxygen with polymeric materials results in the formation of simple oxides of each element present.

Additional studies on atomic oxygen focused on the rate of interaction with various polymers and in developing polymeric systems which are more resistant to interaction with atomic oxygen. Table 1 shows the mass loss for various materials after exposure to atomic oxygen. It is clear that fluorinated materials are resistant to attack by atomic oxygen. It has also been shown that silicon-containing materials are similarly resistant[1]. To test the effectiveness of silicon-containing compounds in polymeric systems, polydimethylsiloxane (PDMS) was incorporated into two polymers; a polysulfone (P1700), and a polyetherimide (Ultem). Films of both system were cast and samples of each were exposed to atomic oxygen. The results are shown in Table 2. Since the incorporation of PDMS in the polymer film was effective in reducing the attack by atomic oxygen, other silicon-containing compounds are currently being assessed.

It was shown on several Space Shuttle flights that the interaction of atomic oxygen with polymeric materials results in surface erosion[2]. We have employed diffuse reflectance infrared spectroscopy to study surface interactions. A graphite-Ultem composite was studied by comparing the diffuse reflectance infrared spectrum before and after exposure to atomic oxygen. The data show that certain chemical groups on the polymer interact more rapidly than others. Specifically, the carbonyl group seems to react most rapidly, followed by the imide and methyl groups. The benzene ring appears to react more slowly than the other groups. The structure of Ultem is shown in Figure 1.

Irradiation by energetic electrons and ultraviolet radiation is the greatest environmental hazard to polymeric materials in the geosynchronous orbit. To assess the resistance of materials to these radiations, a unique apparatus was built at the NASA Langley Research Center. It consists of a chamber 9 inches in diameter and 9-inches high into which a sample can be mounted. The chamber can be evacuated to a pressure of 10^{-8} torr. An electron gun and a mass spectrometer are also incorporated in the vacuum system, and an ultraviolet lamp is positioned so that the sample can be irradiated with electrons and ultraviolet radiation simultaneously or separately. The mass spectrometer can monitor the volatile products from the interaction of the radiations with the polymeric material. While some background problems have plagued the instrument, we have obtained some results for polysulfone. When this polymer is irradiated with either electrons or ultraviolet radiation, the mass spectrum shows peaks at mass 48 and at mass 64. These masses correspond to the chemical structures SO and SO_2. Other workers have shown that SO_2 is a product of the irradiation of polysulfone[3]. The structure of polysulfone (P1700) is shown in Figure 2. This study will be extended to include other polymeric materials.

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TABLE 1.

Mass Loss of Materials After Exposure to Atomic Oxygen

Material	Exposure Time (min.)	Mass Loss (mg)	% Loss
Graphite Fiber (HMS 34-1)	360	121	80.0
FEP Teflon	375	2.6	2.4
Polysulfone (P1700)	375	46.7	56.9
Polyetherimide (Ultem)	300	9.0	25.0

TABLE 2.

Polymeric Materials Containing Polydimethylsiloxane (PDMS)
Exposed to Atomic Oxygen

%PDMS (by weight)	Polysulfone (P1700) Exposure Time (min.)	Mass Loss (mg)	% Loss
0	180	5.8	8.8
0.43	180	3.2	6.5
0.89	180	2.2	5.6
	Polyetherimide (Ultem)		
0	360	24.2	29.0
1.35	360	12.5	13.1
4.31	360	12.7	12.8

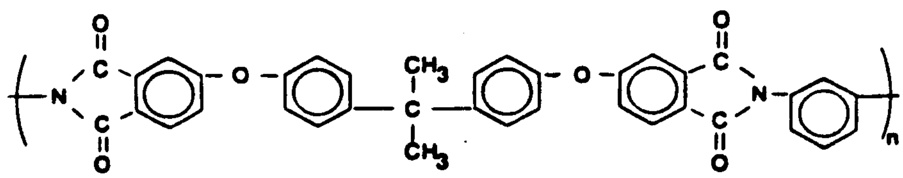

Figure 1. Chemical structure of polyetherimide (Ultem).

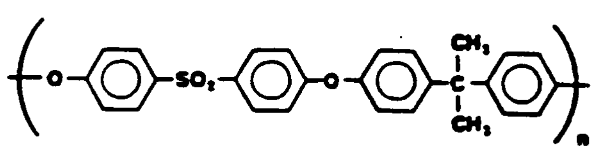

Figure 2. Chemical structure of polysulfone (P1700).

ANALYSIS OF BONDED COMPOSITE MATERIAL STRUCTURAL COMPONENTS USING A HIGHER ORDER PLATE THEORY

by

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The use of composite materials in modern aircraft structures has seen rapid growth in recent years. As these laminated materials are used in more complicated configurations the effect that one composite component has on another becomes pronounced. A typical way to join composite sub-components is to bond them together using an adhesive. The stress distribution in one component becomes coupled with that of another component through the adhesive layer.

In this work, the sub-component interaction between two laminated composite plates (e.g. a wing skin joined to a flange) was investigated. A higher order plate theory was developed that accounted for; a) interface tractions due to the adhesive bond and b) shear deformations within the two plates. A system of 36 differential equations and the corresponding boundary conditions must be solved simultaneously for this problem. Typical coupling modes are a function of both geometric and material parameters. A parametric study will be conducted to determine which parameters strongly influence the stress distributions in the plate and flange. Knowledge of the stress distributions will help in the design of safe, flight-worthy structures.

ROLE OF THE CHARGE-TRANSFER COMPLEX IN THE LASER-INDUCED COPOLYMERIZATION OF MALEIC ANHYDRIDE AND STYRENE IN ACETONE

by

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The Ultimate goal of this research is to explore the scientific feasibility of laser-induced polymerization as a future fabrication technique of space-stable materials, such as composites, foams, adhesives, and films, in the microgravity environment of space. Presently, however, the aims of the basic photopolymerization research being carried out are to enhance our understanding of the kinetics and reaction mechanisms involved in the polymerization process and to determine the effects of microgravity on the composition, structure and mean molecular weight of the photoinitiated polymers. The styrene-maleic anhydride systems was chosen for these studies.

It has been suggested that in the copolymerization of styrene and maleic anhydride in a liquid medium (acetone, in these studies), the propagation proceeds via the monomer-monomer donor-acceptor complex (charge-transfer complex). Thus it is essential that preliminary studies be performed to characterize this charge-transfer complex. Furthermore, experimental parameters needed for an understanding of the initiation mechanism were investigated and obtained in terms of the complex, the monomers, and the solvent. In this regard the methods of UV absorption spectroscopy and proton NMR spectroscopy were utilized.

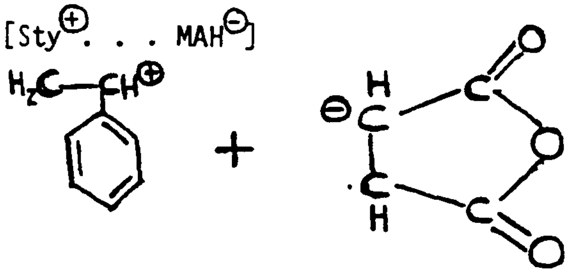
The existence of a styrene-maleic anhydride donor acceptor complex was firmly established as complexing gave rise both to charge-transfer bands in the UV spectra and to chemical shift changes in ^1H NMR spectra of styrene-maleic anhydride mixtures. The UV band of the complex lies in the wavelength range of 320nm to 375nm, with a λ_{max} at 330nm. The complex has a 1:1 stoichiometry as determined by Job's continuous variation method. From the proton NMR studies, the formation of this complex is governed by an equilibrium constant, K_c^{AD}, of 0.28 L mol^{-1} at room temperature. The enthalpy and entropy of formation of the complex are -5.7 KJ/mol and 29J/K.mol, respectively.

The absorption spectrum obtained for pure styrene starts around 312nm. The vapor absorption spectrum of maleic anhydride at 80^{o}C indicates that for this monomer, absorption starts at a wavelength of about 360nm.

The presence of the charge transfer (CTC) absorption band from the UV spectral studies would lead to the following initiation mechanism on exposing the CTC to a laser that is tunable over its wavelength range to form radical ions:

$$\text{Sty} + \text{MAH} \rightleftharpoons [\text{Sty} \; . \; . \; . \; \text{MAH}] \rightarrow [\text{Sty}^{\oplus} \; . \; . \; . \; \text{MAH}^{\ominus}]$$

$$[\text{Sty}^{+} \; . \; . \; . \; \text{MAH}^{-}] \xrightarrow[\text{Appropriate Laser}]{h\nu}$$



It is also possible that the initiation could proceed via the formation of a maleic anhydride excimer. The exact photoinitiation pathway will be determined when the photolysis is carried out as a function of the appropriate wavelengths obtained from the UV absorption studies.

DIFFUSION OF SUPERCRITICAL LIQUID

OXYGEN INTO HIGH PRESSURE AIR

by

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In aerospace wind tunnels methane burners are used in order to obtain the desired conditions (Mach number, temperature, etc.). In the case considered, oxygen-enriched air is blown to the burners. The enrichment is performed by an injection of liquid oxygen (LOX) into the stream of atmospheric air, as shown on the enclosed sketch.

The injection process is limited by the available pressure drop. Injection and subsequent mixing of LOX with the carrier air has to fulfill several conditions. The most important one is to achieve a homogenous oxygen concentration within the carrier air, say with a $\max(\Delta C/C_{ave})$ of oxygen (before the methane burners) below 5-10%. Other conditions are: avoidance of LOX impingement on the system (duct) walls and mixture flow without oxygen "pockets," standing vortices, induced vibrations, or swirl-type flow patterns.

The work on the problem, which involves several disciplines, was divided as follows: (a) LOX injection, (b) jet and droplet ballistics, (c) simultaneous heat and mass transfer in and from jets and droplets, and (d) molecular, convective, and turbulent diffusion.

Main difficulties in solving this complex task stem from the natural coupling of the above listed processes, the time dependence and 2/3 dimensionality of the phenomena involved, as well as from the following: non-ideal behavior of participating gases (O_2, N_2), scarce data on jet dynamics and on transport properties under given conditions of the problem.

A thorough phenomenological solution approach was selected, minimizing the number of purely empirical coefficients. Unknown or insufficiently known effects are being considered and evaluated through numerical feasibility studies, including the assessment of extreme cases and conditions.

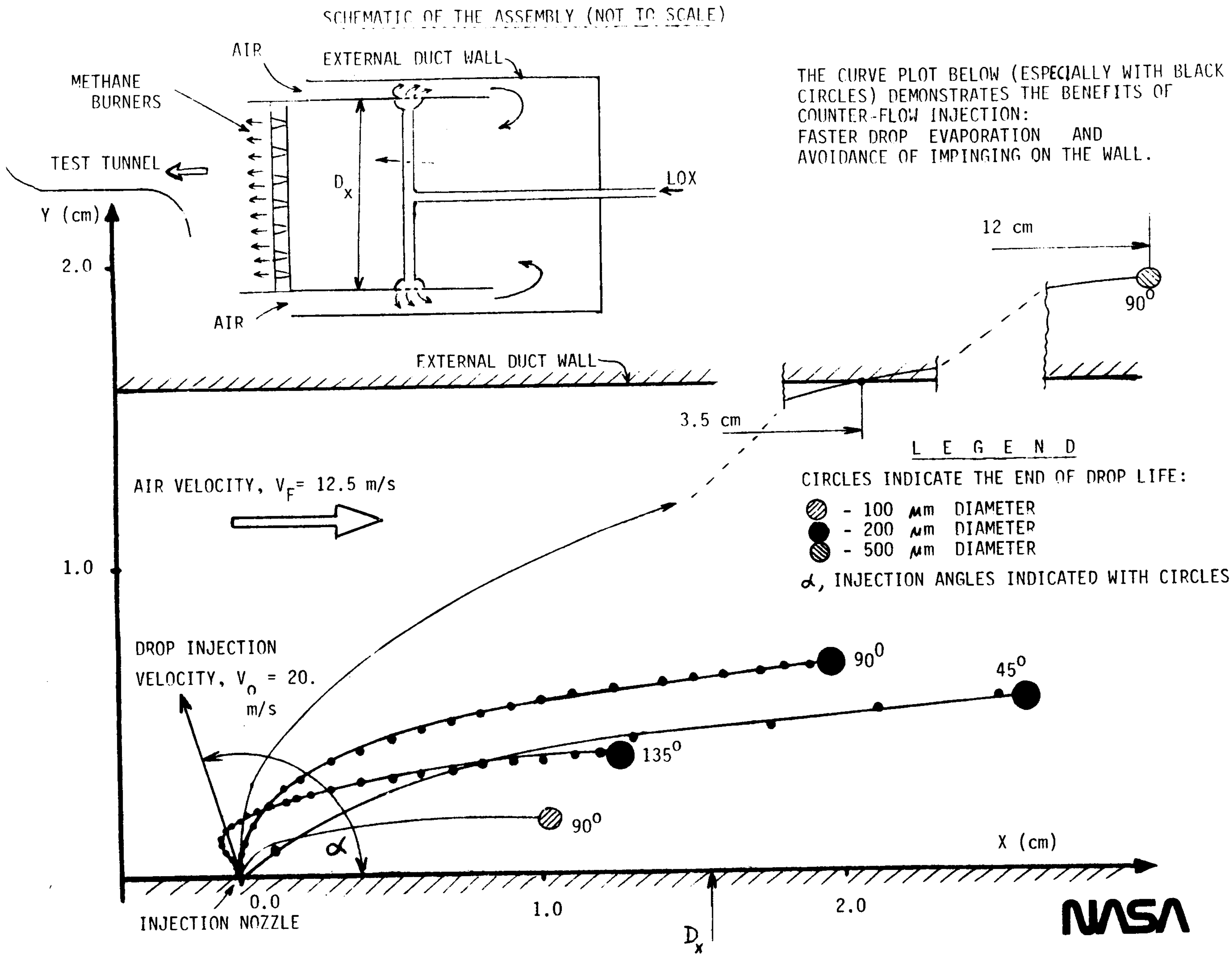
Regarding the modeling of complex phenomena, drops are considered as spheres with temperature dependent properties, without internal circulation; also, their rotation is being neglected. Several dynamic models of drops were considered: with constant diameters and mass, with constant mass, with variable diameter and mass of liquid. An important result of drop ballistics and evaporation is its end of life. In the constant diameter model, that is the time when drop's center reaches the oxygen saturation temperature corresponding to the pressure of the carrier air. The big dots on drops' trajectories (see the figure) represent the end of drop's life. For the more advanced model, where the drop has a variable mass and diameter, the end of life is the time when drop's (liquid core) diameter becomes zero.

The final analysis considers a drop-size distribution (histogram).

Oxygen diffusion into the carrier air occurs during the lifetime of the drops and afterwards, the latter being a gas-gas turbulent diffusion. A plausible physical model is introduced, wherein each drop travels in its "cell," i.e., an air volume associated with the drop. A straightforward analysist shows that the ratio of the two radii, that of air-cell versus the drop's, is: $\frac{R_a}{R_d} = \left(\frac{\text{volumetric flow rate of air}}{\text{volumetric flow rate of LOX}}\right)^{1/3} = 2.88$ for the operating point of the test tunnel defined below. This result holds for a uniform drop's distribution throughout the duct.

A few interesting results are, for $\dot{m}_{LOX} = 45.45$ kg/s and $\dot{m}_{air} = 121$ kg/s. O_2 mass concentration in the carrier air increases from 23.2% to 44.2%. O_2 injection process parameters - for a pressure difference between LOX and air of 3.5 bar (50 psi) - are: LOX velocity at injection holes is 24 m/s, independent of holes' diameter. The following parameter is only pressure-difference dependent: $N.d^2 = 2122\ mm^2$, d being nozzle hole diameter, and N the total number of holes, e.g.: if one selects N = 240, d $\cong$ 3 mm. Many other (N, d) pairs are feasible.

CONCLUSION: The problem can be analyzed with a high accuracy. Results obtained so far are encouraging. Helpful technical modifications are possible, e.g., jet break-up conditions can be enhanced by small nozzle diameters, upstream jet injection and jet collisions. Another helpful feature is the prolonging of droplets' residence time; the above mentioned upstream (counter-flow) injection would contribute to this goal, too. Jets/droplets impingement on the duct wall can be avoided: for this purpose "flat" injection angles are preferred, even if they may require an addition of small nozzle-carrying surface protrusions into the air flow; these would be helpful in creating additional turbulence, which will intensify the mixing.


SCHEMATIC OF THE ASSEMBLY (NOT TO SCALE)
AIR
EXTERNAL DUCT WALL
METHANE BURNERS
TEST TUNNEL
D_x
LOX
AIR
THE CURVE PLOT BELOW (ESPECIALLY WITH BLACK CIRCLES) DEMONSTRATES THE BENEFITS OF COUNTER-FLOW INJECTION:
FASTER DROP EVAPORATION AND AVOIDANCE OF IMPINGING ON THE WALL.
12 cm
90^0
Y (cm)
2.0
EXTERNAL DUCT WALL
3.5 cm
L E G E N D
CIRCLES INDICATE THE END OF DROP LIFE:
- 100 μm DIAMETER
- 200 μm DIAMETER
- 500 μm DIAMETER
α, INJECTION ANGLES INDICATED WITH CIRCLES
AIR VELOCITY, V_F= 12.5 m/s
1.0
DROP INJECTION VELOCITY, V_0 = 20. m/s
90^0
45^0
135^0
90^0
X (cm)
α
0.0
INJECTION NOZZLE
1.0
2.0
D_x

The Analysis of Approximation Errors in the Evaluation of the Reliability of Complex Fault Tolerant Control System Models

by

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Rapid technological advances have heightened the need for highly reliable control systems for power plants, aircraft, weapons systems, etc. Since it is virtually impossible to statistically test devices that are designed to operate for decades without failure, new means of assuring reliability are required and are being developed. Fault tolerant control systems are based on extreme redundancy at the component or modular level. Faults occur rarely and are, when they do occur, masked (often through voting schemes) until such time as the faulty component has been detected and can be removed, repaired, or replaced. Since redundancy can easily be made extreme, the inability to reconfigure from the occurrence of a fault before system failure can occur, called coverage failure, is the primary cause of system unreliability. The probabilistic nature of the occurrence of coverage failures is, therefore, of considerable interest to reliability analysts.

For reasons mentioned, the primary method of investigating the reliability of fault tolerant systems is not through physical life testing. Instead, current efforts tend to center on building suitable models and determining the reliabilities associated with these models. These include fault tree models and, more commonly, highly complex Markovian or semi-Markovian stochastic processes.

The more realistic and seemingly applicable of these models are themselves so complex that exact or even near-exact reliability predictions from them are difficult to obtain. As a result, much effort has gone into developing mechanized tools to help evaluate the predicted reliabilities of the models themselves. Foremost among these tools are packages called SURE [1], CARE [2], and HARP [3], whose primary purpose is to assist the engineer in determining the reliability of a particular model for a fault tolerant control system.

None of these tools is assured of even coming close to obtaining the actual model reliability. Massive state spaces and intractable systems of differential/integral equations force the adoption of numerous seemingly reasonable and intuitively negligible approximations in the course of estimating the model reliability.

This current research focuses on the overall theoretical effect of certain frequently used model-simplifying assumptions and on the determination of bounds for the error incurred in using the automated reliability tools. Specifically, instantaneous coverage approximations are argued under most general conditions to yield conservative estimates of model reliability, and this fact is applied to the analysis of other bounds found in the literature and to the CARE package. The most frequently used CARE model is shown to be conservative, and rough bounds on the error of CARE are investigated. Generalizations and extensions of these results are currently in progress.

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A Study of Superhard Carbon Films

by

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Superhard coatings are of use in industrial applications such as for making wear resistant grinding and cutting tools and in defense applications where they may be used to minimize damage to optical components from very high powered lasers. Diamond like carbon films and polycrystalline diamond films are of particular interest due to their large optical bandgap, thermal conductivity, and extreme hardness. The films are useful as mirror coatings and as high temperature electronic components if they can be doped to obtain a p-n junction.

A great many attempts have been made at growing diamond films with varying degrees of success. All techniques have thus far yielded slow growth rates (10 Å/hr) and films ranging from soot to graphite to diamond. The most common growth technique and the least understood is plasma decomposition of hydrocarbon gases such as methane. The quality of the resulting films depend on the microwave or rf power used to decompose the gas and on the substrate type and preparation procedure.

We have endeavored to grow films by microwave decomposition of a methane (5%) and hydrogen mixture. The rationale for including hydrogen is that it dissolves graphitic formations and hence improves film hardness. We are just beginning to succeed at growing hard carbon films.

A considerable effort has gone into examining the work currently underway in this diversified field. We attended the SDIO/IST conference on diamond technology where researchers presented many papers on film growth. The most pressing issues are how to increase growth rates and improve film quality. From these talks and the published literature, we have been able to map a course of study.

The film quality depends intimately on the way early stages of growth. In a subsequent proposal to be submitted to NASA, we will propose surface differential reflectometry or ellipsometry for in situ investigation of the optical constants of the first monolayers of deposited carbon. These studies are made possible by the high sensitivity of the experimental techniques to changes in the dielectric function. The slow growth rates will be our ally, allowing measurements over extended wavelengths to be taken before the film undergoes significant change.

A DECISION SUPPORT SYSTEM (DSS) FOR ON-ORBIT OPERATIONS

by

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An on-orbit operations model has been developed for NASA by Computer Sciences Corporation (CSC). This Decision Support System (DSS) can be used to assess the impact of system/subsystem technologies, designs, and operational philosophies on crew time, operational costs, and Space Station productivity. The computerized model, hereafter referred to as OPS Model, uses a data-driven simulation approach, and is designed for an IBM PC/XT or PC/AT.

The utility of OPS Model as a modeling tool was demonstrated by simulating a variety of on-orbit logistic support activities for the Space Station. This specific scenario modeled on-orbit inventory monitory (12 ORUs); on-orbit preventive maintenance, corrective action, emergency repair, propellant resupply; ORU replacement; telerobotics maintenance; STS rendezvous and transfer of supplies; uniform distribution on repair time; task travel times; crew mix/crew availability; conditions/priorities; monitoring of 10 experiment setups; orbital day/night cycle; and work breakdown schedule. The scenario was replicated 100 times in an attempt to analyze the effects of repair time variability, task travel times, preemption times, and crew resource constraints. It was determined that OPS Model facilitates both single- and multi-parameter sensitivity analyses, and enables a synergestic evaluation of Space Station components.

The use of OPS Model as a scheduling mechanism for on-orbit experiments was also evaluated. A Longest Duration Time algorithm with a premempt-resume mode was developed for eventual implementation in OPS Model. It was determined that the decision maker can currently model simple scheduling heuristics with OPS Model by a judicious use of a prioritization scheme. The scheduling rules of Longest Duration Time, Shortest Duration Time, 2 Class, and Random were compared with regard to makespan, or the time required to complete all experiments. It was determined that the scheduling rule of Longest Duration Time first was a good heuristic to follow when attempting to minimize makespan. Also, the crew skill profile directly influenced the time to complete all experiments. More research is needed in the development of a dynamic sequencing and scheduling algorithm for on-orbit experiments and/or space manufacturing applications. Such an algorithm would significantly enhance the decision support capabilities of OPS Model, and lead to the development of alternative operational philosophies for the Space Station.

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Operation of $Ti:Al_2O_3$ in a MOPA Configuration

By

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The LIDAR (Light Detection and Ranging) Program is an integral part of NASA's remote sensing program. A key to the improvement of the LIDAR experiments is the development of tunable, high-pulse energy lasers that are efficient in power, weight and volume. The goal of this research is to develop a solid-state laser system that will meet these needs.

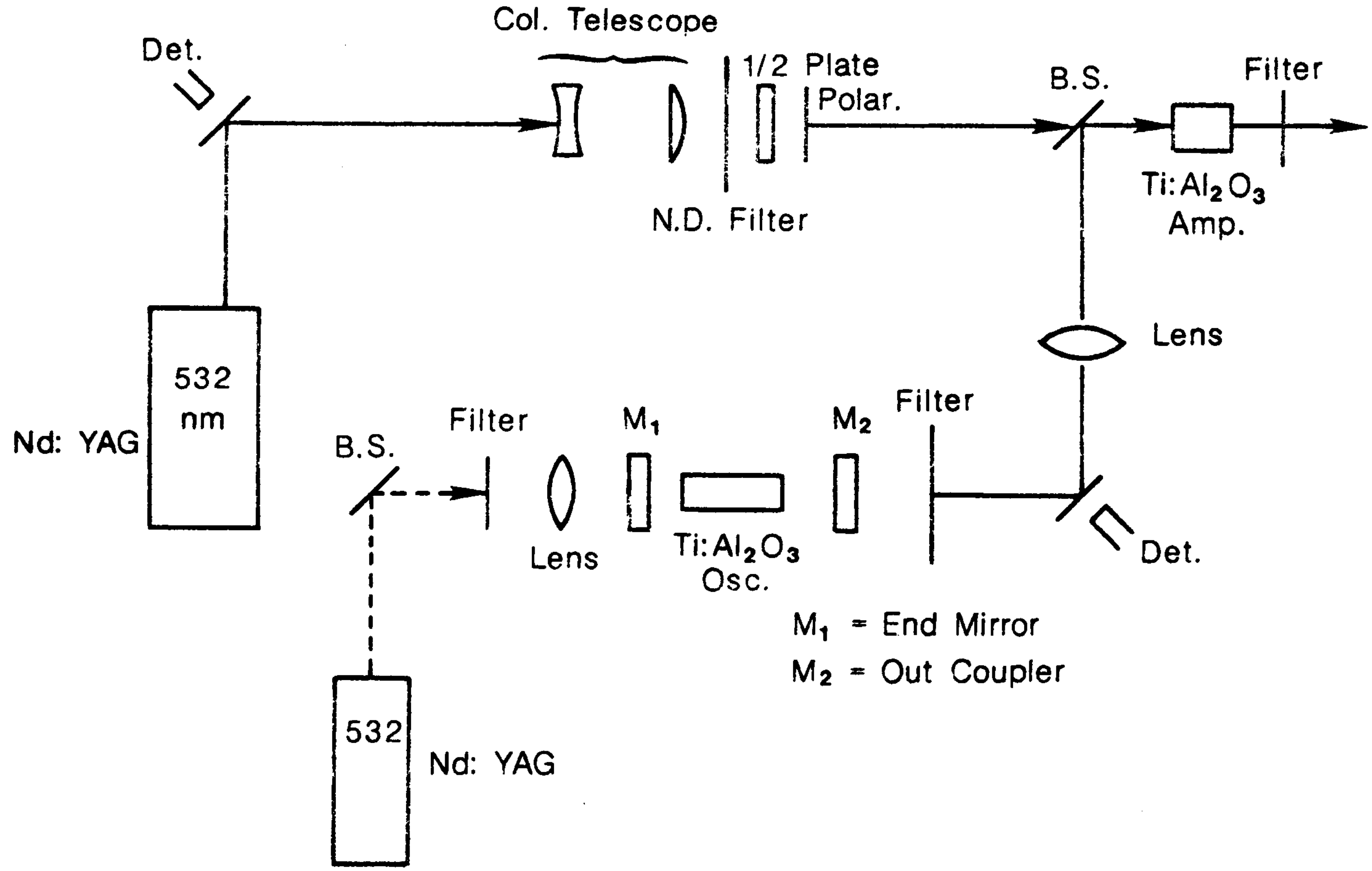
A $Ti:Al_2O_3$ laser operating in a MOPA (Master Oscillator Power Amplifier) configuration, Figure 1, could fulfill many of the scientific needs of the LIDAR experiments. Specifically such a system would provide:

1. Tunability over the 0.72 to 0.95 m range to access the H_2O and O_2 bands.
2. Narrow linewidth operation for spectral resolution of these bands.
3. High gain for efficient energy conversion to the near-infrared.

Because $Ti:Al_2O_3$ is a solid-state vibronic laser, its emission range is quite large. Taking advantage of this allows one to tune over a wider frequency range than with conventional lasers, i.e., gas, chemical. Narrow spectral-linewidth operation is somewhat more difficult to obtain because of the short buildup time for laser emission. Therefore, for narrow-linewidth operation intercavity line-narrowing elements must be used, i.e., etalons. Due to the high gain of the $Ti:Al_2O_3$ system, one does not lose much in terms of the total output energy of the laser.

Using a frequency-doubled Nd:YAG as a pump source, a $Ti:Al_2O_3$ laser in a MOPA configuration was tested. Conversion efficiencies in the oscillator were very high. Work is now in progress to maximize the conversion efficiencies in the amplifier to increase the output energy.

MOPA Configuration



Verification and Validation of Knowledge-Based Systems

by

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A knowledge-based system solves problems requiring a large degree of domain-specific knowledge. Verification is the process of determining conformance to a written specification of the system; validation of is the process of assessing whether the knowledge has been captured and employed in a manner that satisfies the intended users of the system.

A life cycle based on rapid prototyping is frequently used to develop knowledge-based systems. This cycle consists of three stages: (1) Knowledge acquistion: expert knowledge is obtained from interviews, readings, and observations. (2) Knowledge encoding: the extracted knowledge is represented in a manner amenable to computer processing. (3) Validation: test cases are used to provide feedback to the expert, causing the loop to begin again at (1). Development systems that support rapid prototyping of knowledge-based systems focus on providing mechanisms for encoding expert knowledge. Once the system has been validated, improved performance can sometimes be obtained by translating it into a conventional programming language.

Missing from this approach to constructing knowledge-based systems is the written requirements for the system. Without this specification, the assessment of the resulting system relies on the constant feedback of experts in the application domain. This results in an excessive burden on the experts and inhibits any independent assessment of reliability or correctness. Furthermore, the traditional advantages of component testing are absent since the system is always treated as a whole.

Methods of incorporating specifications and verification into the rapid prototyping life cycle of a knowledge-based system are being investigated. A model is being developed that supports diverse verification techniques such as testing, analysis, and formal proof of properties for knowledge-based systems. Relationship of these verification techniques to the ultimate reliability of the knowledge-based system is of primary concern.

STRUCTURE/CONTROL SYSTEM DESIGN IN THE PRESENCE OF RANDOM STRUCTURAL PARAMETERS

by

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Traditionally, structures and control systems of space structures have been designed separately. The structure is typically optimized to minimize weight with prescribed stiffness constraints. The control system is designed to minimize a quadratic performance index which includes structural energy and control effort. Recently, however, there has been considerable interest in simultaneous structure/control design (refs. 1-4).

For on-orbit purposes, the structure/control system will be designed to meet certain mission objectives; i.e., the structure may have to be pointed or maintain a prescribed shape with a specified degree of accuracy. Moreover, the system will be required to suppress vibration due to orbit disturbances (e.g., spacecraft docking, gravity gradients, and thermal gradients) with a minimum prescribed dynamic performance; i,e., the real part of the closed-loop poles (eigenvalues) must meet specified constraints.

The design analysis must include probability considerations as the structural parameters such as modulii of elasticity, mass density, cross-sectional areas, member lengths, etc., are random due to many variables including temperature fluctuations, gravity gradients, and manufacturing inaccuracies. To accomplish the mission objectives, the structure/control system may be over-designed; however, the cost of constructing the system may be prohibitively high.

Here, we propose to examine structure/control system design in the presence of random structural parameters. Moreover, it is of interest to design the structure/control system so the probability that the system does meet the dynamic performance requirements is increased.

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Vortex Detection in an Image Sequence

by

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The shape and some geometrical properties of vortices in an image sequence are of interest in the study of blade-vortex interaction (BVI) noise. To obtain the shape and geometrical measurements of a vortex, one requires first to detect it in an image which may contain some other objects. The shape of the vortex appears to be in elliptical or circular form, but may not be described precisely by analytical means. The use of the Hough transform in detection of circles and ellipses seemed initially plausible; however, this approach appears to be cumbersome. Mainly, because it is computationally very expensive and more importantly the shape of the vortex core will get distorted in the process and consequently will no longer remain a circle or an ellipse.

To detect the vortex in an image frame, a new method is proposed. The proposed method consists of three steps: (1) the image frame is smoothed and thresholded by an appropriate value; (2) the resulting binary image of step 1 may contain small holes, we fill these holes by expanding and shrinking the image by a unit distance; and (3) the major thrust of this method lies in this step, where a modified thinning algorithm produces a one point wide, connected vortex, while removing all other undesired elements in the image. This method appears to be more effective in the sense that the whole flow of air determines the shape of the vortex rather than the vortex core which may not go through major changes. Moreover, it is computationally much cheaper than a Hough transform based scheme.

Eigenstructure Assignment for Control of Highly Augmented Aircraft

by

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Eigenstructure assignment is an excellent method for incorporating classical specifications on damping, settling time, and mode decoupling into a modern multivariable control framework. In this research, we consider the application of eigenstructure assignment to the design of flight control laws for aircraft with many control effectors.

We show that a previous eigenstructure design for the control of the FPCC aircraft lateral dynamics with three control effectors exhibits a lack of robustness to parameter uncertainty. This problem is traced to a weak dependency relationship between the three aerodynamic control surfaces. We derive a method for reducing the control space to two dimensions by using the singular value decomposition. After the design is complete, we map the controller back into the three-dimensional control space. This technique yields a flight control law with adequate input multivariable stability margins as measured by the minimum singular value of the return difference matrix.

This technique is utilized to design flight control laws for the lateral dynamics of the F-18 High Angle of Attack Research Vehicle (HARV). This aircraft has four lateral aerodynamic control surfaces plus thrust vectoring. We map the control inputs into a two-dimensional space and compute an output feedback gain matrix by using an eigenstructure assignment design method. Then the control inputs are mapped back into the original five-dimensional control space. An interesting characteristic of the mapping is that at widely different angles of attack, the most effective control inputs have the larger gains and the least effective control inputs have smaller gains. Thus, at each angle of attack the control inputs which are most effective at that angle of attack are given the most emphasis in the flight control law.

A VIDEO INVESTIGATION/PRESENTATION OF NASA-LANGLEY RESEARCH CENTER'S ENGINEERING TECHNICIAN APPRENTICE AND COOPERATIVE EDUCATION PROGRAM(S) WITH EMPHASIS ON ENGINEERING TECHNOLOGY

by

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The primary purpose of the proposed investigation is to amplify through video investigation and presentation, the development and growth of the Engineering Technician Apprentice and Cooperative Education Programs at NASA Langley Research Center.

Within this context, the investigation and video presentation will focus on the role of high school and junior college students who are selected into the program.

Attention will be devoted to qualifications, training and career development paths for those students who successfully complete all phases of the admissions process.

One method devised to meet the academic and professional manpower needs of the National Aeronautics and Space Administration is the NASA Langley Research Center's Engineering Technician Apprentice and Cooperative Education Engineering Technology Program(s).

Initial investigation indicates a high degree of satisfaction with employee participant graduates of the program, however, additional program design is suggested to increase and enhance recruitment efforts and success.

Several factors prompt reconsideration of the recruitment effort. Among the most significant appears to be the need to attract more qualified candidates into the Engineering Technician Apprentice and Cooperative Education Programs. This need is further exemplified when explored in the context of manpower needs and the emerging aerospace technology. Given the current state-of-academic-affairs in high schools and junior colleges, coupled with the growing demands for highly skilled, well trained hi-tech oriented youth, competition for the "Best and the Brightest" is keen. Private industry may offer more money to high school and junior college graduates who show higher potential for success thereby dwindling the pool of candidates available for service in the government sector. More specifically, government agencies such as NASA, which not only require but also demand highly skilled, proficient hi-tech oriented individuals must become more competitive in their efforts to attract todays youth.

As a result of todays highly competitive recruitment activities on behalf of private industry, the NASA Langley Research Center's Engineering Technician Apprentice and Cooperative Education Engineering Technology Programs seeks to enhance its recruitment effort(s).

A proposed modification of the recruitment effort centers around the production of a video magazine that visually depicts the role of the apprentice/aerospace technician in a variety of position (job) related activities.

The significance of this approach is couched in the concept of shared information. The the project is designed to reach the widest number of potential employees in an effort to have a positive and direct impact on their career choice.

The method and principal vehicle selected to influence the career choice of potential employee participants (i.e. high school and first year college students) is a video tape produced through the office of the Technical Co-Op/Engineering Technician Training Coordinator.

ORIGINAL PAGE IS
OF POOR QUALITY

A SOLAR SYSTEM CURRICULUM

by

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The Solar System Curriculum is designed to present NASA research to elementary students, Grades 1-6, while meeting learning objectives for science proposed by state Departments of Education. The integrated curriculum was conceived by the NASA Education Office, Washington, DC, as part of a new focus on elementary students. Precipitating factors leading towards the NASA commitment to elementary students is found in the recent literature on science and math.

The notion of a "crisis" in math and science is supported by the shortages of qualified teachers in those subject areas (Lawrenz, 1986). With only 1-1/2% of high school graduates choosing science as a field of study (Brunkhorst & Yager, 1986), the National Science Teachers Association suggests a new kind of science which is appropriate and useful for all. This emphasis on reform took the shape of an integration of science and mathematics (House, 1986).

Further, an analysis of a teacher and learner dyad reveals that students' positive attitudes toward the learning of science are strongly correlated with those same students' perceptions of teacher enthusiasm (Lawrenz, 1986). A look at elementary school teachers' weak background in the sciences, especially in the physical sciences, leads us to assume that they might be less enthusiastic in their teaching. It would seem then that to counteract the effect of the poorly trained teacher on the teaching of science, curriculum initiatives must include the following:

1) Relevance: (Math-science integration and a current topic focus)
2) Training: (Conceptual science knowledge/problem solving format)
3) Sources: (Sources other than textbook or series of activities)

The Solar System Curriculum is being developed according to the above guidelines.

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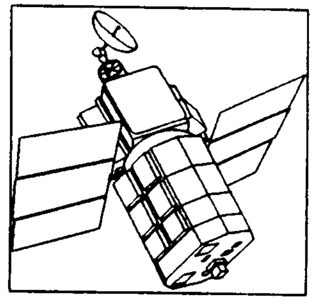
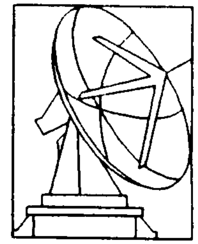
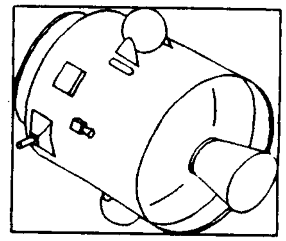
SOLAR SYSTEM CURRICULUM

Scope and Sequence







GRADE 1

Earth in Space
Earth's Satellites
Models

GRADE 2

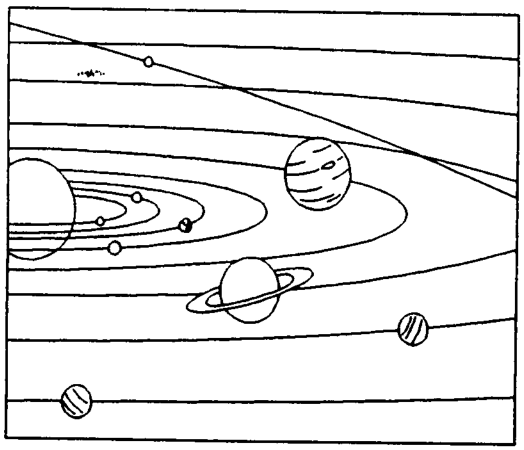
Earth as a System
Earth-part of a System
(Earth-Moon Satellite)

GRADE 3

Sun as a System
Solar Info Systems
Sun-Earth System

GRADE 4

The Solar System
Planet Sub-Systems
Info-Gathering Systems



GRADE 5

Electromagnetism
Getting Out There
Scale Drawings

GRADE 6

Energizing Spacecraft
Stars
Computations

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CHAOTIC BEHAVIOR IN LASERS

by

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Systems of ordinary differential equations that exhibit chaotic behavior have been the subject of intensive research during the past several years [1]. Key features of chaos are the lack of predictability in the time evolution of a solution and exponential divergence of two solutions with nearly the same initial conditions. This type of behavior has been observed in dynamical systems that arise, for example, in chemical kinetics, fluid dynamics, and population biology. Reference 1 contains numerous examples as well as computer generated phase space plots of solutions to chaotic systems

Present research focused on dynamical systems that describe the photon - ion inversion interaction in lasers. It was found that a number of published results claiming chaotic behavior in the dynamical systems describing laser action appear to be incorrect. Certain modifications to the systems, however, do exhibit the period doubling route to chaos.

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Development of A Digital Optical Displacement Measuremet Technique

(Applied to the Belt Skin Friction Transducer)

By

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July 1987

ABSTRACT

The importance of viscous effects in fluid mechanics has been the motivation for a number of theoretical and experimental studies. Particular attention has been given to the frictional forces introduced by the flow on the surfaces of moving bodies. This is of great importance in reducing drag and improving performance of aircraft and watercraft. For the general turbulent boundary layer there exists no commonly accepted theory to predict the flow parameters and provide information on the wall shear stress and surface heat transfer etc. Due to the limitations associated with the prediction methods available and with indirect measurement techniques such as preston tube, hot film sensors etc., direct measurement of the wall shear stress is more desireable. Additional detail may be found in reference 1.

Through previous efforts, mainly supported by the NASA LaRC, a small instrument has been developed for the direct measurement of wall shear stress generated by fluid flow on a surface, Ref. 2. This instrument is simple and symmetric in design with small moving mass and no internal friction. It is basically small and can be made in various sizes and for different ranges. The features employed in this design eliminate most of the difficulties associated with the traditional floating element balances and vibration effects were found to have been

minimized. Dynamic measurements could be performed presently in a limited range. Information gathered by this instrument will provide the data base necessary for a more foundamental understanding of shear stress and turbulent boundary layers.

This instrument can be set-up with various sensing systems and the output signal is a linear function of the wall shear stresses applied on the instrument. Through static calibration, a linear relationship for force as a function of displacement of the sensing element is obtained. Therefore, displacement is directly related to the tangential forces (shear stresses) applied to the sensing element of this balance. A complete description of this instrument including sample calibration may be found in reference 2.

Presently strain gauges are used to measure the strain generated on the flexures which is proportional to the displacement of the sensing surface of the balance. Under normal ambient conditions the strain gauges are very good with the only disadvantage being the fact that they are relatively large. However, in adverse environments such as cryogenic or high temprature (reentry) conditions strain gauges are not good candidates. Ideally, accurate non-contact measurement of the belt displacement is required for the optimum operation of this instrument.

A digital optical displacement sensing technique has been conceived and is being developed. This concept uses optical viewing of a coded surface to determine the position of that surface relative to a reference point. The coding is in form of microscopic (micron) size protorusions spaced two microns center to center embedded permanently onto a transferable surface. The coded area is scanned with the beam of a laser diode transmitted by a small optical fiber and focoused onto a small region. The reflected light is carried by another optical fiber to a light sensitive transistor. The output of the light sensitive transistor is digitized and is a function of the relative position of the coded surface with respect to the optical fibers through calibration.

As a result of this optical measurement technique, the sensitvity of the belt skin friction balance shall be increased. In an indirect way this translates to the fact that a much smaller instrument can be manufactured with sufficient sensitivity. That is; a very small transducer can be manufactured for direct local skin friction measurements even on small models made for wind tunnel testing. Alternately, a more robust transducer can still have useful accuracy at a small fraction of its operating range.

This optical displacement sensing technique has the potential to be developed and used as a linear array to detect the relative position of an object in a non-contact manner. One typical application of this approach will be in determining the model position in the magnetic suspension and balance system. This technique may be more economical and affordable in comparison with other techniques with comparable resolution.

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PRETREATMENT OF PLATINUM/TIN OXIDE CATALYSTS FOR THE OXIDATION OF CO IN A CLOSED CYCLE CO_2 LASER

by

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The application of pulsed CO_2 lasers to aerospace research in such areas as the Laser Atmospheric Winder Sounder (LAWS), flight engine exhaust analysis, and wind shear detection has been well documented (ref. 1). The use of this laser on airborne or space platforms necessitates operation in a closed cycle, The electrical discharge which provides energy for the laser also decomposes some of the CO_2 into Co and O_2 and the presence of this O_2 causes a rapid loss in power leading to erratic behavior. Recombination of the CO and O_2 can be caused by the passage of the gas mixture over a heated, solid catalyst. Results of catalyst studies have been reported in reference 1 as well as in the catalysis literature. One of the most effective catalysts reported is platinum supported on tin oxide, the Pt/SnO_2 catalyst.

The project was the laboratory evaluation of the Pt/SnO_2 catalyst(s) in terms of its pretreatment, oxidation state, and its operational history. A reactor was used as a surrogate laser system in order to emulate laser operation. A computer controlled gas chromatograph was used to analyze the gases produced after passage of mixtures of CO and O_2 in helium, 2% neon as an internal standard over the catalyst at different temperatures and flowrates. The effect of pretreatment of the catalyst with oxidizing, reducing or inert gases upon the conversion efficiency was studied. The effects of pretreatment temperature and pretreatment time was also studied.

The catalyst studied in depth was a $2\%Pt/SnO_2$ catalyst furnished by Engelhard Industries. This catalyst had a surface area of 6.9 square meters per gram as measured by a BET experiment. This catalyst was best pretreated with a reducing gas such as H_2 or CO (5% in helium) at elevated temperatures while treatment with an inert gas such as helium or with an oxidizing gas such as 5% O_2 in helium resulted in considerably lowered conversion efficiencies for a 1% CO-0.5% O_2 mixture at 358 k. An extended dip in conversion efficiency as a function of time was noted in these cases before the conversion efficiency ultimately rose to a final value. The causes for this initial dip in conversion efficiency were investigated and it was found that the presence of small amounts of water vapor during pretreatment eliminated this dip. It was also found that pretreatment at lower temperatures (398 K versus 498 K) yielded a much smaller and shorter dip. Extended pretreatment at the higher temperature with CO gas also resulted in lower ultimate conversion efficiencies.

One can conclude from these studies that hydroxyl entities (OH) on the surface of the catalyst are somehow involved in the catalytic process.

Further investigation using the surrogate laser system as well as direct surface measurements needed to clarify the situation.

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Accelerating Graphics Processing Using Ada's Concurrent Programming Techniques

by

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The structure of most computer graphics packages has been constrained by the underlying computer software along with time constraints imposed by computer architectures. With the development of new programming techniques and advanced computer architecture, some constraints in processing graphic applications are being reduced. Research in the area of parallel processing has stimulated research in concurrent (parallel) programming. In this research, concurrent programming is used to explore the structuring of a graphics package. The Ada programming language, which was developed for DoD, incorporates programming techniques including information hiding, error handling, and using modular structures (packages and tasking). By incorporating these new features into the implementation of the graphics package, alternative structures are investigated to determine which routines can be combined or separated into modules. The structure of the modules is based on the relationship between the different graphics routines. These modules are programmed using the added features of the Ada programming language as research tools.

INVESTIGATIONS OF AMPLIFIED SPONTANEOUS EMISSION

by

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The amplified spontaneous emission (ASE) photon flux distribution and power radiated from several amplifier geometries has been studied. The geometries include individual cylinders, amplifier chains of varying component geometries and radiating level densities, and conical sections whose doping profiles is chosen to produce a constant pump and amplified power densities. A useful closed form approximation for both the photon ASE flux and power is presented for cylindrical amplifiers which can be used over the entire range from low to high amplification and over a range of radius to length from zero to about ninety. The expression for the power is applicable to a variety of spectral shapes including quadratic, Gaussian, Poisson and Lorentizian. The approximations are applied to a chain of variable amplifier sections. The ASE flux can be obtained in closed form, a constant power density conical amplifier form when the condition gain coefficient equals 2 divided by conicalradial position, is satisfied. The ASE power from a constant power amplifier is extremely low compared to other conventional geometries.

IMPACT OF WIND SHEAR ON AIRPLANE PERFORMANCE

by

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A previous study[1] showed that classical methods of aerodynamic and performance analysis can easily be applied to the investigation of the performance degradation of airplanes in horizontal wind shears. Application of the methods to the determination of best technique for traversing a wind shear produced a result similar to those obtained from tests using piloted simulators.[2] The analysis was restricted to the takeoff and climb of large airplanes.

This report discusses the extension of the study to small airplanes and to the landing maneuver.

The typical analytical climb performance portrayal has used the shear entry rate $\dot{w}_x$, in knots/sec., to represent the shear. Use of constant values of $\dot{w}_x$ for climb plotting is obviously deceptive in that it presents the airplane with a different shear for each climb speed used. The shear velocity gradient or spatial shear intensity, w_x, does not contain the airplane speed, and is thus the proper shear parameter to use for comparative purposes. The climb potential can be expressed as

$$\dot{h}_p \cong (R/C)_u - \frac{w_x V^2}{g}$$

which allows the effects of airspeed and shear intensity to be viewed separately. The range of airspeeds over which a given airplane can climb successfully in a shear is smaller than that conveyed by the use of $\dot{w}_x$.

This change of parameter also allows the relative performance of large and of very small airplanes to be more easily visualized. The still-air climb rates of such aircraft can differ by factors of four or more, but the pertinent climb speeds can differ by factors of two to three, which indicates that the climb rate degradations due to shear will be in somewhat the same proportion. Shear intensities of interest for the large airplanes will thus also be of interest for the small.

Landing flare performance is degraded by the presence of a shear in the same way as is takeoff transition. Investigation of flares of a small airplane from power-off approaches indicates that though the shear intensity close to the ground may have decayed, the increased approach descent rates due to the shears still dictate that flares be commenced higher or that roundouts be more severe, or both. Time available for flaring is typically short enough to render successful maneuvering by relatively inexperienced pilots difficult. Varying approach speed has little effect on this result. Best climb potential exists for flap-up configurations.

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VERIFICATION AND VALIDATION OF ARTIFICIAL INTELLIGENCE SYSTEMS

by

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Verification and validation (V & V) are software engineering techniques used to assure us that computer programs/systems meet specified requirements. These techniques have been formalized and are routinely used in the development of "traditional" software projects.

Artificial Intelligence program development has been largely experimental and, until recently, very little effort has been expended assuring that these programs meet user requirements. My work this summer has been focused on developing methods to perform rigorous V & V of Artificial Intelligence (AI) programs. The test bed for my research was a demonstration version of the Faultfinder program[1], which was developed by the Intelligent Cockpit Aids Team (ICAT) from the Vehicle Operations Research Branch (VORB). This program uses AI techniques to determine if a fault exists (or is developing) in aircraft systems. The program then notifies the pilot.

Investigation revealed that, for procedural portions of the implementation, traditional software engineering techniques work well. However, these methods were found to impose undue restrictions on normal AI development regimens and to be inadequate for the AI portions of the system.

Some problems are attributable to the way AI development is typically done. Most AI development is conducted using prototyping which differs radically from standard software engineering program developments. Prototyping doesn't support the creation of detailed specification, design, and test documentation. This severely hampers the V & V phase because there is relatively little traceability of program function to user requirement and there is no specific description to evaluate test results against. The prototyping scenario <u>can</u> be successfully modified to include truncated and more flexible documents called "goalspecs." These documents are a formalization of the typical vague goals commonly used but are considerably less encompassing and directed than rigorous specifications. Design and test documentation should also be similarly transformed.

Faultfinder contains two modules which use AI techniques. The modules are named Stage1 and Stage2. Stage1 is a rule based system, Stage2 is a model based system.

Stage1

The rule base itself must be verified and validated. This was usually done by the experts (pilots, technicians, and aircraft documentation). This step is insufficient and must be augmented by checking the rule base for consistency and completeness.[2] A small set of consistency checks were implemented and found to be an important requirement in V & V. We must also use portions of the rule base as functional test data.

Stage2

The functional and physical structures of the aircraft are modeled in a knowledge base. Any fault symptoms which reach this stage are localized and a fault hypothesis is generated. V & V of Stage2 entails rigorous application of traditional logic testing. The information contained in the model must also be tested. Modified consistency and completeness checks may be appropriate. Evaluation by the experts is mandatory. It is also necessary to provide a trace of the decision making process for each test result. Evaluation of this decision making process by experts is required. Future V & V techniques of model based systems may well be AI based themselves.

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ON SCALING OF AIRFOIL PERFORMANCE IN HEAVY RAIN SITUATIONS

by

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The flow over an airfoil under heavy rains is one of a two-phase, two-component dispersed flow. An experimental program has been initiated by NASA-Langley to study the aerodynamic behavior of the airfoil under heavy rain situations[1]. A set of scaling parameters is needed in order to extrapolate the subscale test data to full scale. Currently, an appropriate set of scaling parameters is not available due to the many unresolved fundamental phenonmena involved, particularly near the surface of the airfoil. Bilanin[2] has applied the Buckingham Pi-Theorem to the present problem and obtained nine scaling parameters. It is understood that the set of scaling parameters so obtained are not unique. Moreover, the relative importance of the scaling parameters cannot be assessed from a pure Pi-Theorem analysis.

Here, a different approach is taken, which involves nondimensionalization of the governing equations and boundary conditions using properly chosen scales for the physical parameters associated with the two-phase flow field. As a result, a set of scaling parameters have been derived from the governing equations. This set of scaling parameters has definite physical significance and is specific to the problem studied. It is consisted of a phase coupling number, a relaxation number, a density ratio, the free stream Reynolds number, and the Froude number [3]. Of these, the phase coupling number and the relaxation number are specific to a dispersed two-phase mixture.

The order of magnitudes of the five scaling parameters mentioned above have been estimated under typical heavy rain and flow conditions. It is shown that the number of scaling parameters is further reduced to two: the Reynolds number and the relaxation number. Consequently, the simplified governing equations no longer contain the liquid water content variable (see reference [3]). It suggests that the aerodynamic behavior of the airfoil may be insensitive to the liquid water content for a range of liquid water content values. This may explain some of the wind tunnel data of Dunham[1].

The present effort pertains only to the governing equations. This is because the governing equations for the type of flow studied here are quite well established. However, a complete formulation of any physical phenonmenon must also include the boundary conditions.

Presently, the boundary phenonmena are not yet well understood to allow a correct formulation. An additional set of scaling parameters will be associated with the nondimensional boundary conditions. By separately nondimensionalizing the governing equations and the boundary conditions, it is possible to isolate the important areas of study. For instance, the potential effects of the liquid water content are pointed towards the phenonmena occurring at the boundary rather than in the interior flow field. Finally, it is the purpose of the present work to complement the existing work done on scaling issues in heavy rains and to provide new insights into the problem.

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Structural Dynamics and Vibrations of Lightly Damped Structures: A Method for Preliminary Design Analysis

by
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The transient and steady forced vibrations of aircraft, rotorcraft and spacecraft structures are oftentimes analyzed as complete systems with hundreds or thousands of degrees of freedom. Also, there is ordinarily slight amounts of damping that can be represented by viscous and/or structural-hysteretic damping of a passive character. Modern analytical and numerical finite-element type methods are generally rather effective at predicting the undamped natural frequencies and associated modal patterns of free vibration, but much less so at representing the system damping and its influence in the steady forced vibration response, especially near the peak resonant responses. Moreover, the ability of current methods to be employed as preliminary design tools is severely limited due to the complexity and cost of attempting to represent and compute the influence of isolated substructure passive damping, as well as any local and global damping treatments.

It is the objective of the current research program to derive and develop engineering approximative methods which employ the free, undamped modes of vibration of complex structures to predict their transient and steady forced vibratory responses in the presence of slight amounts of localized system damping. It has been shown that an energy related algorithm reminiscent of the Rayleigh quotient accurately predicts the decay factors in transient vibrations and the effective modal damping ratios in forced vibrations. This can be done with simple calculations, and permits a rapid and inexpensive preliminary design procedure which determines the efficiency of specific local, as well as distributed, damping treatments on a mode-by-mode basis. The engineering science basis of this result is two-fold: first, a mathematically rigorous proof that the damped system damped natural frequencies have stationary values with respect to perturbations of the damped modal vectors, thereby permitting the use of the undamped modal vectors in the calculations of the modal damping factors for lightly damped systems; second, a power series solution for the damped system oscillations is developed which treats the damping factors and/or damping ratios as small parameters in a power series solution, with the zeroth order solution as the undamped system, the first order correction proportional to the damping ratio, second order correction proportional to damping ratio squared, etc.

Future goals of the research include systematic comparison of data predicted by the preliminary design method with digital computer, finite element computations employing their complex algebra capability to predict the damped frequencies and damped modal vectors, first of simplified and then complex structural systems. Experimental verifications are to follow.

ELICITING STRATEGIC OBJECTIVES AND CONSTRUCTING A STRATEGIC PLAN FOR LaRC'S ADMINISTRATIVE INFORMATION

BY

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The role of Electronic Data Processing (EDP) has dramatically changed during the past two decades. The principal role during the 1960's and early 1970's was to support transaction processing systems i.e., the operational level within the organization. Increasing managerial needs coupled with advancements in database technology expanded the role of EDP to include support for the management level . The unit responsible for insuring the appropriate and timely processing of information to both the operational and management level came to be known as the Management information Systems Unit (MIS). However, one of the possible explanations for the failure of many MIS systems is that they have been designed using the conventional "bottom-up" approach that characterized the development of the earlier EDP's Such design approach primarily emphasized the pursuit of <u>efficiency</u> through cost/time savings rather than the pursuit of enhanced organizational <u>effectiveness</u> (ref. 1). Recently, many managers began to realize that the achievement of greater organizational effectiveness is the paramount consideration in most of the management decisions which MIS is to support (ref.2) and consequently it must also be of paramount importance in the design of the MIS. Moreover, more and more organizations are now using their information systems to help top level management achieve strategic competitive advantages. The systems designed to support the strategic level of management are now dubbed Strategic Infromation systems (SIS) (ref.3).

NASA LaRC is composed of a powerful Research sector and a Management Operations (MO) sector whose primary function is to provide administrative support to the Center. In other words, the MO directorate's job is to provide LaRC's top management and the research directorates with timely, convenient, and effective <u>strategic</u>, <u>tactical</u> ,and <u>operational</u> information to support LaRC's mission and objectives. It thus follows that there is an intrinsic linkeage of the decision-supporting MIS to the LaRC's <u>policy</u>, <u>objectives</u> , and <u>strategy</u>.

Business Data Systems Division (BDSD) is the MO unit responsible for the processing of <u>all</u> administrative information in LaRC. However, due to its historical evolution, it has and to a large extent still is, concentrating only on transaction processing data ;i.e., operational information. Opportunities available through current advances in information technology are not being exploited as they should. We propose the following methodology that will enable the MO directorate and its BDSD division use the vast possibilities made available by information technology to assist LaRC's top management and their research directorates :

1. Change the mission of BDSD from that of just supporting transaction processing to that of using information technology to support the MO Directorate and the research Directorates and Divisions by providing strategic, tactical, and operational information as needed. The following diagram portrays a proposed way for exploiting the current capabilities of information technology to support the opertational, tactical, and strategic objectives of LaRC.

```
+----------+      +---------+
|          |      |         |
|          +------+         |-------STRATEGIC }
|  MODEL   |      |  DATA   |                 }  ALL
|          |      |         |                 }
|          |      |         |--------TACTICAL }  LaRC
|   BASE   +------+         |                 }
|          |      |         |                 }
|          |      |         |                 }
|(DSSs &   |      |         |                 }  USERS
| Expert   +------+  BASE   |-------OPERATIONS}
| Systems) |      |         |
|          |      |         |
|          |      |         |-------TRANSACTION} (Only
+----------+      +---------+       PROCESSING }  MO Users)
```

2. Define the MIS strategy set based upon MO's mission, objectives, strategies which in turn are extracted from Larc's mission, objectives, strategies and other strategic attributes. The following chart portrays the proposed process .

```
LaRC's Strategy set                              Define MO's strategy
Director's memo #106                             Set to support LaRC's
January 1987                                     strategic mission
+--------------------+                           +------------------+
|LaRc mission        |  MO Streategic            |MO's mission      |
|Objectives          +---------------------------+Objectives        |
|Strategies          +---------------------------+Strategies        |
|Other strategic     |  Planning Process         |Other strategic   |
|    attributes      |                           |    attributes    |
+--------------------+                           +-------+----------+
         +-------------------------------------+
         |
         |                   BISD's strategic
         |                         Plan
         |                 +---------------------+
         | MIS strategic   | Systems objectives  |
         +-----------------+ Systems constraints |
           Planning Process| Systems design      |
                           |     strategies      |
                           +---------------------+
```

3. Change the name of Business Data Systems Division (BDSD) to Business Information Sytems Division (BISD) to reflect its new mission . It will also be necessary to modify some of the job descriptions , the qualifications of the personnel, and the organization of the current division as proposed in the following organization chart.

```
                          BISD
                            |
  +---------------+------+------------+------------------+
  |               |                   |                  |
 Database       Applications   Distributed         Computer
Administration  & DSSs         Computing &         Center &
                               Telecommunications  Data Input
```

References

1. Dearden, John. "MIS is a Mirage." Harvard Business Review . January-February 1972.

2. King, William. "Strategic Planning for Management Information systems." MIS Quarterly , March 1978, pp.27-37.

3. Rackoff, Nick ; Wiseman, charles and Ullrich Walter. "Information Systems for Competitive Advantage: Implementation of a Planning Process" MIS Quarterly , December 1985.

APPENDIX V

ASEE-NASA Langley Summer Faculty Program

Sample Questionnaires

AMERICAN SOCIETY FOR ENGINEERING EDUCATION

NASA/ASEE Summer Faculty Fellowship Program
Evaluation Questionnaire

(Faculty Fellows are asked to respond to the following questions)

Name: ______________________________

Birthdate: ______________________________

Social Security Number: ______________________________

Permanent Mailing Address: ______________________________

____

____

____

Home Institution: ______________________________

NASA Center and (Laboratory) Division: ______________________________

Name of Research Associate: ______________________________

Brief Descriptive Title of Research Topic: ______________________________

____

____

A. Program Objectives

1. Are you thoroughly familiar with the research objectives of the research (laboratory) division you worked with this summer?

   Very much so ________
   Somewhat ________
   Minimally ________

2. Do you feel that you were engaged in research of importance to your Center and to NASA?

   Very much so ________
   Somewhat ________
   Minimally ________

3. Is it probable that you will have a continuing research relationship with the research (laboratory) division that you worked with this summer?

   Very much so ________
   Somewhat ________
   Minimally ________

4. My research colleague and I have discussed follow-on work including preparation of a proposal to support future studies at my home institution, or at a NASA laboratory.

   Yes ______ No ______

5. What is the level of your personal interest in maintaining a continuing research relationship with the research (laboratory) division that you worked with this summer?

   Very much so ________
   Somewhat ________
   Minimally ________

B. Personal Professional Development

1. To what extent do you think your research interests and capabilities have been affected by this summer's experience? You may check more than one.

   Reinvigorated ________
   Redirected ________
   Advanced ________
   Just maintained ________
   Unaffected ________

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2. How strongly would you recommend this program to your faculty colleagues as a favorable means of advancing their personal professional development as researchers and teachers?

With enthusiasm ______
Positively ______
Without enthusiasm ______
Not at all ______

3. How will this experience affect your teaching in ways that will be valuable to your students? (you may check more than one)

By integrating new information into courses ______
By starting new courses ______
By sharing research experience ______
By revealing opportunities for future employment in government agencies ______
By deepening your own grasp and enthusiasm ______
Will affect my teaching little, if at all ______

4. Do you have reason to believe that those in your institution who make decisions on promotion and tenure will give you credit for selection and participation in this highly competitive national program?

Yes ______ No ______

C. Administration

1. How did you learn about the Program? (please check appropriate response)

______ Received announcement in the mail.
______ Read about it in a professional publication.
______ Heard about it from colleague.
______ Other (explain). ______________________________

____

____

2. Did you also apply to other summer faculty programs?

Yes ______ No ______

______ DOE
______ Another NASA Center
______ Air Force
______ Army

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3. Did you receive an additional offer of appointment from one or more of the above? If so, please indicate from which.

____

4. Did you develop new areas of research interest as a result of your interaction with your Center and laboratory colleagues?

   Many ______
   A few ______
   None ______

5. Would the amount of the stipend ($800) be a factor in your returning as an ASEE Fellow next summer?

   Yes ______
   No ______
   If not, why ____

   ____

6. Did you receive any informal or formal instructions about submission of research proposals to continue your research at your home institution?

   Yes ______ No ______

7. Was the housing and programmatic information supplied prior to the start of this summer's program adequate for your needs?

   Yes ______ No ______

8. Was the contact with your research colleague prior to the start of the program adequate?

   Yes ______ No ______

9. How do you rate the seminar program?

   Excellent ______
   Very good ______
   Good ______
   Fair ______
   Poor ______

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10. In terms of the activities that were related to your research assignment, how would you describe them on the following scale?

Check one per Activity	Time Was			
Activity	Adequate	Too Brief	Excessive	Ideal
Research				
Lectures				
Tours				
Social/Recreational				
Meetings				

11. What is your overall evaluation of the program?

Excellent ______
Very good ______
Good ______
Fair ______
Poor ______

12. If you can, please identify one or two significant steps to improve the program.

____

____

____

____

____

13. For second-year Fellows only. Please use this space for suggestions for improving the second year.

____

____

____

____

____

D. Stipend

1. To assist us in planning for appropriate stipends in the future would you indicate your salary at your home institution.

   $__________ per __________.

2. Is the amount of the stipend the primary motivator to your participation in the ASEE Summer Faculty Fellowship Program?

   Yes _____ No _____ In part _____

3. What, in your opinion, is an adequate stipend for the ten-week program during the summer of 1987?

   $__________________

E. American Society for Engineering Education (ASEE) Membership Information

1. Are you currently a member of the American Society for Engineering Education?

   Yes _____ No _____

2. Would you like to receive information pertaining to membership in the ASEE?

   Yes _____ No _____

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PLEASE USE THIS PAGE FOR YOUR COMMENTS TO ANY QUESTIONS

EVALUATION OF SUMMER RESEARCH PROGRAM

(NASA-ASEE)

BY

FELLOWS

Please complete and return to Suren Tiwari by July 27, 1987, NASA MAIL STOP 105A.

1. Were you able to obtain sufficient information regarding the program?

   YES NO (Circle One)

   Comments: ____

   ____

   ____

   ____

2. Was the contact with your anticipated research associate an early one to allow some preparation for the research assignment?

   YES NO (Circle One)

   Comments: ____

   ____

   ____

   ____

3. Were you given a choice of research topics?

   YES NO (Circle One)

   Comments: ____

   ____

   ____

   ____

4. Have you found your research problem:

   A. Challenging? YES NO (Circle One)

B. Within your chosen field of interest? YES NO (Circle One)

Comments: ______________________________

____

____

____

5. Do you plan to embark on research of similar nature upon your return to your home institution?

YES NO (Circle One)

Comments: ______________________________

____

____

____

6. First-Year Fellows: Do you plan to return to Langley next year, if invited?

YES NO (Circle One)

Comments: ______________________________

____

____

____

7. Did you find the lectures that you attended of interest? Any suggestions for the future.

YES NO (Circle One)

Comments: ______________________________

____

____

____

8. Your comments regarding the stipend you received would be appreciated.

Comments: ____

____

____

____

9. Did you experience difficulty in locating suitable housing?

YES NO (Circle One)

Comments: ____

____

____

____

10. Was the adminstration of the program to your satisfaction?

YES NO (Circle One)

Comments: ____

____

____

____

11. Additional comments regarding the program as a whole. You may use the back of this page also.

Comments: ____

____

____

____

12. If you anticipate publishing a paper as a result of your research this summer, please provide the title of paper and journal in which you anticipate it being published.

Comments: ____

____

____

____

13. If you plan on submitting a proposal for continuance of your research effort this summer, please provide title of proposal and agency to which proposal will be submitted.

Comments: ____

____

____

____

Signature ____________________

NASA-ASEE

SUMMER FACULTY RESEARCH PROGRAM

QUESTIONNAIRE FOR RESEARCH ASSOCIATES

Please complete and return to Suren Tiwari by August 7, 1987, NASA MAIL STOP 105A.

1. Would you say that your Fellow was adequately prepared for his/her research assignment?

   YES NO (Circle One)

   Comments: ______________________________

   ____

   ____

   ____

2. Would you comment on the diligence, interest, and enthusiasm with which your Fellow approached his/her research assignment.

   Comments: ______________________________

   ____

   ____

   ____

3. Would you be interested in serving as a Research Associate again?

   YES NO (Circle One)

   Comments: ______________________________

   ____

   ____

   ____

4. Would you be interested in having your Fellow (if eligible) return a second year?

YES NO (Circle One)

Comments: ____

____

____

____

5. Any recommendations regarding improvement of the program will be appreciated.

Comments: ____

____

____

____

____

Signature ______________________

APPENDIX VI

Group Picture of 1987 Summer Fellows

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Group Picture of 1987 Summer Fellows

First Row - Left to Right:

Surendra Tiwari, Edmond Koker, Woon-Shing Yeung, Maurice Young, Clarence de Silva, Kenneth Sobel, Barry Ganapol, Kathy Ames, Yi-ling Chiang, Kakkattukuzhy Isaac, Peter Walsh, Devendra Garg, Ezzatollah Salari, J. Patrick Lang, Joseph Hafele

Second Row - Left to Right:

George Miller, Gerald Evans, James Luxhoj, Nenad Kondic, William Brewer, John Van Norman, Richard Kiefer, Carl Abdersen, Jeffrey Bennighof, Robert Willis, Leon Donaldson, Reginald Walker, Mark Norris, Calvin Lowe

Third Row (Back) - Left to Right:

Samuel Massenberg, Robert Wattson, Thomas Huston, Ahmad Vakili, Thomas Carney, Winston Farrar, Larry Morell, Alton Highsmith, Eric Klang

Not Shown

Patrick Barber	Joan Sprigle-Adair
Randall Caton	John Swetits
Charles Spellman	Ahmed Zaki

NASA
National Aeronautics and Space Administration

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15. Supplementary Notes

Langley Technical Monitor: Dr. Samuel E. Massenberg

16. Abstract

Since 1964, the National Aeronautics and Space Administration (NASA) has supported a program of summer faculty fellowships for engineering and science educators. In a series of collaborations between NASA research and development centers and nearby universities, engineering faculty members spend 10 or 11 weeks working with professional peers on research. The Summer Faculty Program Committee of the American Scoiety for Engineering Education supervises the programs. Objectives: (1) To further the professional knowledge of qualified engineering and science faculty members; (2) To stimulate and exchange ideas between participants and NASA; (3) To enrich and refresh the research and teaching activities of participants' institutions; (4) To contribute to the research objectives of the NASA center. Program Description: College or university faculty members will be appointed as Research Fellows to spend 10 weeks in cooperative research and study at the NASA Langley Research Center. The Fellow will devote approximately 90 percent of the time to a research problem and the remaining time to a study program. The study program will consist of lectures and seminars on topics of interest or that are directly relevant to the Fellows' research topic. The lectures and seminar leaders will be distinguished scientists and engineers from NASA, education or industry.

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